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HISTOCHEMISTRY: THE GROWING SCIENCE

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Professor of Anatomy

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"HISTOCHEMISTRY: THE GROWING SCIENCE"

By

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INTRODUCTION

This inaugural lecture is unique in some respects; (i) being the first to emanate from the Department of Anatomy and Cell Biology of our Faculty of Basic Medical Sciences; (ii) being presented by a pioneering academic member of staff of the then Faculty of Health Sciences (the first to be recruited in 1971). Although there had been two Professors of Anatomy in the Department, but for some inexplicable reason(s) it is not clear why they did not or could not inaugurate the chair of Anatomy in this University hence it has somehow become my duty, privilege and honour to do so.

I have chosen as the subject of my discourse, the topic "HISTOCHEMISTRY: THE GROWING SCIENCE". To the uninitiated, HUMAN ANATOMY simply translates to the study of, structures, that make up the body, either with the naked eye or with the aid of appropriate instruments designed for such purpose. To the initiated, Human Anatomy stretches far beyond this narrow concept. A better knowledge of the structural organisation of Man emerges when the information acquired with the naked eye is supplemented with those observed with the aid of a microscope as in HISTOLOGY or in the course of development as in EMBRYOLOGY: or the chemical anatomy of the cells and tissues as in CYTOCHEMISTRY and HISTOCHEMISTRY, respectively. HUMAN ANATOMY thus constitutes an umbrella for many academic disciplines including GROSS ANATOMY, EMBRYOLOGY, HISTOLOGY, PRIMATOLOGY, PHYSICAL ANTHROPOLOGY, AUTORADIOGRAPHY, MICRODENSITOMETRY, COMPARATIVE ANATOMY, TERATOLOGY, HISTOCHEMISTRY, ULTRASTRUCTURE, etc.

Keywords

HISTOCHEMISTRY in its simplest definition means the study of the chemistry of the tissues that make up the organ systems. It involves the identification, localisation and visualisation of active groups, macromolecules, pigments, etc, and GROWTH is defined as increase in number and, or size while SCIENCE is defined as acquisition of knowledge through study or practice as distinguished from ignorance or misunderstanding. From the definition of the keywords in the title of my discourse, my duty today is to provide evidence of the increasing data now available on the number or size of the chemical anatomy of the human tissues through study, acquired facts and truths based on

our knowledge and experience. Before I proceed, please permit me to digress a little. One of the notable contributors to the development and growth of Histochemistry was FRANCOISE VINCENT RASPAIL (1794-1878) a French Pharmacist, Botanist, Microscopist and Philanthropist. Raspail was indeed considered as the founder of Histochemistry - Baker^{1,2} (1943, 1945). Raspail studied in detail, the processes of fertilization in flowers and fruits of the *Graminaceae* using the iodine reaction for starch which was first described by Colin and de Claubry³ (1814) and by Stromeyer⁴ (1815). Since then, Histochemistry recorded giant strides in its advances as an important science that cuts across several disciplines of study such as Botany, Zoology, Human Anatomy, Embryology, etc. By 1930, Lison⁵ (1936) had established histochemistry as an independent science and placed it on a modern footing.

The First Nigerian Histochemist

About the 1930's when Histochemistry became an independent and modern science, a young male Nigerian was delivered, to a highly illustrious Lagosian family, in Lagos on the 29th January 1927. Distinguished members of this audience, I present to you my mentor, the distinguished Emeritus Professor Thomas Adesanya Ige-Grillo, M.A.; Sc.D. (Dublin) M.A.; Ph.D. (Cambridge) L.R.C.P.; L.R.C.S. (Ireland) F.A.S. (Nigeria) M.D. (Dublin), Emeritus Professor here at Obafemi Awolowo University, Ile-Ife. He has had a most cherished, fulfilling and extremely distinguished career as the first Nigerian Professor of Anatomy (University of Ibadan); the Foundation Dean (1972) of the then Faculty of Health Sciences (now College of Health Sciences) O.A.U. Ile-Ife; the Foundation Principal of the College of Medicine and Allied Health Sciences, University of Sierra Leone; the foundation Head of the Division of Human Biology and Behaviour (then University of Ife) and the foundation Head, Department of Anatomy and Cell Biology (then University of Ife) the chair of which department, we are now inaugurating.

Professor Grillo, during the course of his career elected to acquire knowledge beyond what a medical education offered to a clinician. Hence, on completion of his medical training at the famous Royal College of Surgeons, Dublin, he proceeded to the glamorous St. John's College, University of Cambridge for a higher degree in science where he became the first Nigerian to make contact with and study the principles and practice of Histochemistry as a science. By 1979,

Professor Grillo had so distinguished himself as a disciplined and authoritative histochemist that he had to his credit no less than seventy-one (71) publications in various learned and international journals in the fields of histochemistry, Electron-Immuno Histochemistry, Endocrinology, etc.

My Involvement:

Standing before you this evening is another, young man, delivered to another illustrious Lagosian family, who in 1966 found himself in the department of Anatomy, University of Ibadan where Professor Grillo was the Head of Department. I had a choice to study Physiology or Pharmacology but somehow ended up studying and acquiring a degree in Anatomy in 1970. On completion of my undergraduate programme at Ibadan, I was recruited into the Academic Staff of the Department much against my will and without applying for the job. I had finished my oral examination the previous evening before a panel of distinguished Professors from outside Nigeria - in fact the panel included Professor Everson-Pearse who wrote the authoritative textbooks on Theoretical and Applied Histochemistry - Principles and practice; Professor Kubota then Chairman of Tokyo Medical and Dental University, Japan and Professor R. Barer of University of Sheffield, England. While preparing to leave for home (Lagos) the following morning, Professor Grillo materialised in his car, walked up to me in my Hall of residence demanding to know why I was not yet in the department. I was filled with trepidation and managed to blurt out that the Professor had forgotten that I had finished my examinations and had nothing more to do in the department and the University other than to go home and into the world. He took a good laugh at that and in his measured tone stated that should I fail to report in the department within the hour he would issue me with a query. He left promptly and left me the more confused and confounded. I ran to the department only to be informed by the Departmental Secretary that I had been offered an appointment as a Research Assistant and he then showed me to my office. I immediately despatched the driver who had been sent to bring me home back to my parents with a note explaining the new development.

Contact With Histochemistry

Professor Grillo advised or rather instructed me to complete application

forms for registration as a post-graduate student for the degree of M.Sc. which I did and my identified project was to investigate the specificity of the metal-salt technique. At this stage of the development and growth of Histochemistry world wide, the demonstration of the activities of the group of enzymes known as non-specific monophosphates was based on the precipitation of a primary reaction product, following the enzyme activity on the substrate, which primary reaction product was then converted into a final reaction product by treatment with yellow ammonium sulphide in a subsequent interaction. This technique was simultaneously developed by Gomori⁶ (1939) and Takamatsu⁷ (1939) while working separately. The method suffered a number of deficiencies but then such was the level of the development of science, hence Histochemistry, and the success of this science is its *specificity, sensitivity and reliability*. Let me elaborate a little further. The group of enzymes classified as non-specific monophosphates include alkaline phosphatase, acid phosphatase, etc, which are active at alkaline and acid pH media respectively but can interact with and hydrolyse a number of substrates. Alkaline phosphatase hydrolyses beta-glycerophosphate to yield energy rich phosphate bonds which are important sources of energy for the metabolic activities of the living cells and tissues. However, the methods of Gomori and Takamatsu were not specific enough and this was the important aspect that I was to investigate. I promptly settled down in the department and became fully engaged in my work. In those days research work was not only a delight but very highly fulfilling; I shall come to this later. As I progressed steadily, I was given yet another assignment which was to develop an alternative substrate for the demonstration of the activity of phosphoamidase which hitherto had para-chloro anilido phosphoric acid as substrate. I again took the project on full steam by searching for a substrate with a chemical structure that is related to the former and we came up with the idea of using Endoxan. The enzyme phosphoamidase has now recently been implicated in the early detection of breast cancer. Having done some serious work in Ibadan, Professor Grillo was seconded, on request, to plan, co-ordinate and establish a medical school for the University of Ife by the Government of the then Western State.

Arrival in Ife: So it was that by 1st August 1971, I was offered appointment as a Research Assistant by the then University of Ife without my applying for the job, without a department and without an

office. I was still doing my research at Ibadan, having resigned, but came regularly to Ife to collect my stipends. By October of same year, the University of Ife offered me probationary study leave without pay and I was off to the Department of Human Morphology, University of Nottingham, England on the twenty-eighth of October, 1971. Within twenty-four hours of my departure I had reported in my new department.

Career in Nottingham: I must remark that I was the first Nigerian post-graduate student to be enrolled in the department of which the eminent Professor Rex Coupland was the Professor and Head and who assigned me to work under Dr. P.F. Harris (later Professor and Head, Department of Anatomy, University of Manchester, 1974). Dr. Harris himself was a protege of the distinguished Professor J.M. YOFFEY who held sway then at the University of Bristol. Phillip Harris and his mentor were supporters and proponents of the monophyletic theory as the basis of the formation of the human blood cells and were in fierce academic debate with the proponents of the polyphyletic theory. In simple language, the monophyletic theory proposed a multipotent stem cell (a single cell) as the progenitor of all the different types of cells in the human blood whereas the polyphyletists contended that each different type of cell had its own separate and independent progenitor. This was where I again became involved. I was promptly and duly registered for the Master of Philosophy (*M. Phil*) degree in October, 1971 and threw myself, head-on, into my assignment. The pressures on me then were many. Firstly, I must not disgrace myself and this great University - The Great IFE - by failing; secondly it was on reputation of this great University and my mentor Professor Grillo that the University of Nottingham accepted me, a Nigerian, as its first postgraduate student in its Department of Human Morphology and thirdly, the family reputation was at stake. By December, 1972 at the scientific conference of the Anatomical Society of Great Britain and Ireland, I presented my first scientific paper titled "Histochemical studies of 'transitional' cells in the bone marrow of the human foetus; evidence for differentiation into granulocytes and monocytes" (Caxton-Martins *et al.*⁸). This was a major contribution to the on-going debate as to the resolution of the identity of the progenitor of blood cells in Man as we were able, for the first time, to show histochemically, precisely and conclusively that at least granulocytes and monocytes in the blood of Man had a common progenitor cell. The scientific importance of this major work was to be highlighted in our next

presentation to the European Anatomical Congress at which we⁹ (Harris, Kugler and Caxton-Martins, 1973) confirmed the "transitional cell" as the Primitive Multipotent Stem Cell (PMSC) or the Progenitor cell for all the different types of blood cells in Man and then went on to reveal that some as yet unclassified forms of leukaemia were indeed "Progenitor Cell Leukaemia" based on our histochemical evidence. By summer of 1973, I had successfully completed and satisfied all the requirements for the award of the degree of the Master of Philosophy which was duly awarded in that year.

At Ife: I was recalled home immediately to reinforce the academic staff strength on ground as the then Faculty of Health Sciences had resumed normal academic activities. The first, that is the pioneering, set of students had just been admitted and all hands were needed to guide and teach the students. This explains why I could not continue directly with my *Ph.D.* programme. I did, and still do not regret suspending my own studies to come home and serve for the reasons that:

- (i) The University did me a great favour by offering me the opportunities it did at the time;
- (ii) the least I should do was to reciprocate that favour and more importantly was that facilities for research work and the learning environment then were comparable to what obtained abroad.

May I at this juncture pay glowing tributes to our founding fathers who had such vision, such commitment to nurture this centre of academic excellence, the GREAT IFE to this level. Were they to rise up from their graves to see the level of decay to which things have degenerated, they would immediately rebury themselves. More on this later. Having settled down here in Ife, I was fully engaged both in teaching and research as well as other sundry services. By March 1974, I was out of the country again, this time to the far East, Japan, where I worked in two great Universities simultaneously, that is, (i) the Tokyo Medical and Dental University and (ii) Kitasato Medical University; learning various techniques such as Electron-Microscopy, Electron-Histochemistry and Electron-Immuno-Histochemistry. It was a unique experience for me being the first Nigerian to be so exposed. After a pleasant six months I returned to Ife to launch myself fully and realistically into Histochemistry and Research.

Histochemistry of the Haemopoietic Systems:

Whilst in Japan in 1974, I worked on and later presented a joint paper to the 10th International Congress of Anatomists on the 'Electron-microscopic and enzyme cytochemical studies of the granulocytes in the peripheral blood of the chicken' wherein we, Daimon and Caxton-Martins¹⁰ evaluated the ultrastructural and cytochemical characteristics of the *White Leghorn* chicken granulocytes in which the functional significance and the implications of their cytochemical characteristics were fully highlighted. This was indeed the beginning of my foray into, and a detailed investigation of the histochemistry of the haemopoietic systems. The question then arises, why the Haemopoietic and not the Renal, Alimentary or any other system? The choice was obvious.

(i) I served my tutelage under a great scientist, Professor P.F. Harris who himself worked under the distinguished Professor J.M. Yoffey who had both spent a greater time in establishing the identity of the progenitor cell of all the cells in the blood and bone marrow of Man; (ii) A comprehensive medical examination of Man cannot be completed and useful without an examination of his blood and (iii) if indeed blood is the "wheels of life" what more challenging system is there to investigate if not the haemopoietic system? These then were my reasons for choosing the system. Then, why descend into other vertebrate groups and not confine my endeavours to only the mammalian class? As is known to us in Anatomy, "Ontogeny recapitulates phylogeny" hence, it is important to know what the situation is concerning the origin, structure and histochemistry of blood cells in Actinopterygian class, up through the Amphibians, the Reptilians, the Avians and finally the mammalian class; that way the reason(s) why a mature circulating erythrocyte in Man becomes anucleated can be easily discerned compared to its nucleated homologue in the Avian or the Reptilian class. The availability of excellent research facilities, conducive learning environment, adequate funding and active scholars stimulated and encouraged serious research activities then.

Research Focus

Ife-Ife is a great centre of culture, in fact the bedrock and cradle of YORUBA culture and civilisation and the Campus of this great University in Ife-Ife abounds with a wide variety of vertebrates most of which serve as sources of animal protein for the inhabitants of the campus as well as the city. As most of these animals are wantonly

captured and killed for economic and nutritional reasons, it behoves us as scientists or as lovers of nature to begin to think of ways of replenishing their population with a view to maintaining and preserving the species. Consequently, aside from studying their haemopoietic system, a conscious effort was also made to do a detailed investigation into their reproductive biology.

Highlights of research findings

Consequently, after a detailed study of the histochemistry of blood and bone marrow cells in the Pangolins¹¹, the fruit-eating bat¹², some reptiles¹³, the amphibians¹⁴ and the actinopterigians¹⁵ we confirmed (a) morphological variation, both in shape and size, from one class to the other; (b) variation in histochemical reactivity, and (c) variation in the intensity of staining reactions between one cell line compared to a similar cell line in different species reflecting species specificity.

(i). **Class Mammalia:** Peripheral blood and bone marrow smears of the pangolin, fruit-eating bat and the guinea-pig were examined histochemically for the activities of Alkaline phosphatase (ALK.P), acid phosphatase, (Acid P), Succinic dehydrogenase (SDH) Lactate dehydrogenase (LDH), Glucose-6-phosphate dehydrogenase (C-6-P-D), and for the presence of glycogen and lipids. The enzymes listed above were investigated based on a careful appraisal of their involvement in the general metabolic activities and energy requirements of the cells and tissues. Alkaline phosphatase is known to elaborate energy-rich phosphate radicals and is also implicated in membrane transport. Acid phosphatase is a marker for lysosomes which constitute part of the intra-cellular defence mechanism. The dehydrogenase involved in the major pathways of glycogen metabolism i.e. Kreb's cycle; Embden-Meyerhof Pathway and the Hexosemonophosphate shunt, were investigated using SDH, LDH and G6PDH as their markers. Where necessary, such other enzymes as Peroxidase, Beta-glucuronidase, etc, were also studied. This pattern was extended to the submammalian classes investigated. (Caxton-Martins)¹⁰⁻¹⁵.

(ii) **Actinopterigian Class:** The clarias and tilapia were investigated from this class as they are common in this area and are also abundant sources of fish protein for human consumption. The shape of the erythrocytes were distinctly circular with the diameter relatively smaller. The nucleus is oval and usually centrally located. Of particular interest in the enzyme histochemistry of this class is the localization of

the activities of the enzymes of glycogen metabolism to the perinuclear region of mature erythrocytes suggesting the presence of "Mitochondrial sites" in this area of the cells. This, in the language of the layman, means that this group of cells unlike their homologues in the mammalian species have higher energy utilisation capacity and higher metabolic activities. All leucocytic cells showed the presence of the non-specific monophosphates as well as enzymes of carbohydrate metabolism investigated, thus confirming their roles as cells involved in cellular-mediated defence mechanisms both as microphages and macrophages in all the classes investigated (Caxton-Martins)¹¹⁻¹⁶.

Tissue Histochemistry-Quantitative and Qualitative Studies

As part of our efforts to investigate certain aspects of the biology of the fruit-eating bats that were then very abundant on the pine trees which served as their roosting colonies in the campus, our focus was shifted to comparing the localization and distribution of the enzymes of carbohydrate metabolism in (a) the skeletal muscles involved in flight and at rest (b) the cardiac muscle and the muscular layers of the great blood vessels. Both objectives were predicated on the observation that in flight the prevailing muscular (cardiac and skeletal) activities were operating against the force of gravity whereas, at rest, in concert, with the same force of gravity. For these studies, Caxton-Martins *et al*^{17, 18, 23} utilised both histochemical and biochemical assay techniques to unravel how this mammal was able to cope with its energy demands in these unique circumstances of the heart pumping blood against gravity while in flight and in concert with gravity while at rest. Our interest in the biology of the fruit-eating bat was not just limited to the skeletal and cardiac muscles alone as we, (Okon *et al*.²⁸, Caxton-Martins *et al*.^{29,30}) also investigated, using histological and histochemical methods, the ovarian cycle, the tongue and the pituitary gland, and all these are pioneering efforts in this area of the biology of the bats in our environment. As earlier noted, the bat is of some considerable economic interest in our locality as a source of free, easily available animal protein to the consumers in the local beer parlours, in the palm-wine bars and even in our Sunday dishes at home, hence the need to understand certain important areas of its reproductive biology (the study of the ovary) and its developmental biology from point of view of the regulatory role of the pituitary on general growth and on the ovarian cycle.

Histochemistry is not just all of a tool for solving basic problems

in the biological sciences but has found application and usefulness in the applied and clinical sciences. We, Odebode, Marquis and Caxton-Martins, (1979)³¹ had adapted it in the study of "Histamine distribution in the Rainbow Lizard alimentary canal" while, Shogbamu, Ifediora and Caxton-Martins, (1989)³² in their work titled "Cytochemical studies of peripheral blood leucocytes...." established the usefulness of glycogen and lipid levels in antenatal assessment of foetal health status while peroxidase levels was implicated as a possible prognostic indicator of foetal birth weight. In the area of reproductive biology, Thomas, Caxton-Martins, Elujoba and Oyelola³³ in an interdisciplinary study evaluated the effects of aqueous extract of cotton seed oil in adult male rats. Cotton seed oil (*Oroko Koro Owu*) in *Yorubaland* is used as a cooking oil and is known to be rich in essential fatty acid, linoleic acid and is widely consumed by the Yorubas. Our findings implicated Gossypol as capable of causing testicular germ cell disorganisation followed by fibrosis of the lumen of the seminiferous tubules within 24 hrs. of intraperitoneal administration. What this translates to in layman's language is that cotton seed oil contains substances that can rapidly cause damage to the testis resulting in adverse intervention in spermatogenesis as well as damage to liver, kidney and muscular tissues. For sometime, the Yorubas have regarded the bat as incapable of visual acuity. This claim has no scientific evidence to support it. This was laid to rest by the work of Caxton-Martins and his collaborators (1992)³⁴ in which we not only established the presence of the superior colliculus, a gland localized in the roof of the midbrain and associated with mediation of visual sensibility in Man, but that it was also highly metabolically active based on the intense activity of SDH and G6PDH observed in the gland thus confirming that the Krebs cycle and the Hexose monophosphate pathway are highly active in the gland. The importance of the activity of alkaline phosphatase in membrane-mediated transport activities in this gland was also highlighted.

PIONEERING EFFORTS IN MICROTECHNICS

As earlier stated, financial support in aid of research and general undergraduate and postgraduate projects at the time that this speaker joined the University system as an academic staff, was reasonably adequate and current technology as at then was also available to the extent that virtually all chemicals and equipment were imported from abroad. Be that as it may, by some misfortune, mismanagement and probably mal-administration the country entered a worsening,

depressing economic phase which seriously affected the general well being of Nigerians as well as the Nation-state. This had indelible marks on the fate of the Universities as Centres of excellence and other sectors of the polity. Generally speaking, education as a programme was the worst for it. At this stage, we in this department threw ourselves into a search for the adaptation of locally available products as substitutes for otherwise imported chemicals and reagents.

These efforts (Caxton-Martins *et al.*^{19, 27, 35, 36}) yielded fruitful results as we were able to find suitable local materials as substitutes offered the following advantages: (i) it was cheaper (ii) it was safer, as being natural products, they were infinitely superior to the imported chemicals which are carcinogenic and hence hazardous (iii) it saved the country and the University a lot of hard-earned foreign currency needed to import the chemicals and (iv) it offered the University an opportunity to patent and hence process these locally available natural materials for export and consequently earn herself foreign currency. We are also happy to note that this our pioneering efforts had stimulated other research teams at the University of Ibadan, the Ogun State University, Ago-Iwoye and the University of Benin into searching for locally available materials for adoption as substitutes in microtechnics. I am equally happy to note that this our modest effort won the department and the University the glamorous first prize, in the National Science and Technology Competition organised by the Federal Ministry of Science and Technology in 1991 with a handsome cash reward of ten thousand naira only.

Our adventure into the field of microtechnics was inspired by the work of Kaplow (1960) ⁴⁰ who had published an article in the *Journal of Laboratory Investigations* in which he described how he successfully adapted commercial hair sprays as a fixative for blood smears. This article intrigued me a great deal that I started pondering over it. What was the active agent in commercial hair sprays that could act as a fixative? Questions and more questions? Then, one day, one of the experienced technologists in our department, Mr. G.C. Ehilegbu, had to work on and submit a dissertation in part fulfilment of the award of a National Diploma of the Nigerian Institute of Science Technology and had approached me to supervise his work. I gave him a reprint of the article by Kaplow and told him that we must look for a locally available, natural product that can be adapted in a similar manner. We both set to work after I had suggested to him that I had always considered our local *Adi Agbon* as a substitute for the following reasons: (i) our women in the rural setting use it to plait their hairs

without any side effects other than the odour; (ii) that most people in the Yoruba setting use it as a skin moisturiser and or liquid pomade and (iii) it was being used as a vehicle/medium for the oral administration of drugs. These qualities point to the fact that it was not toxic, not carcinogenic and not irritable or toxic or both to the human systems. Our initial efforts to adapt it as a fixative was unsuccessful. What next did we have to do? Then, I called in Professor Oluwadiya, an eminent pharmaceutical chemist of this GREAT IFE and after having done a series of pilot studies and literature review and to the credit of Mr. Ehilegbu, we then opted to adapt it as a clearing agent. This met with a huge success and having written up a preliminary report, it was published in the most authoritative journal of Microtechnics in the whole world - *The Stain Technology*¹⁹. This was followed up by more successes as we then, in collaboration with another of our laboratory technologist, Mr. N.A. Ibeh successfully adapted *ELO AKU* and *INYA* as a mounting medium and immersion oil respectively which were published in highly reputable international journals such as *Discovery and Innovation*^{35, 36} and the authoritative *West African Journal of Anatomy*²⁷. What does this contribute to our Science, Technology and Economy? Firstly, for the first time in the whole of Africa, scientists in the field of Microtechnics need not disburse scarce foreign currency to procure these otherwise imported, expensive, carcinogenic and toxic reagents; secondly and more importantly, our young scientists must now become more innovative and visionary in their approaches to problem-solving and thirdly, that given the conducive atmosphere, laboratory facilities and right motivation, our investigators are productive and equal to the task of taking the Nation into the 21st century.

ULTRA STRUCTURAL AND INCIDENTAL STUDIES

The growing scientist, CAXTON-MARTINS, is not just all of a student of HISTOCHEMISTRY alone but, as opportunities presented from time to time, pursued studies that are incidental and relevant to his main focus. Thus, in collaboration with a Japanese scholar and colleague, an ultrastructural and enzyme cytochemical studies on mature chicken granular leucocytes were undertaken which revealed that unlike mammalian neutrophils, mature chicken peripheral heterophils do not show the presence of alkaline phosphatase activity

(Daimon and Caxton-Martins)²⁷ and the investigators concluded that the chicken peripheral eosinophils like their mammalian counterparts are lysosomal in function.

Other incidental studies included microdensitometric studies of Feulgen-DNA variability in the erythrocytes of some Nigerian reptiles Caxton-Martins,²⁰ a study of the lumbo-spinal canals and its anatomical walls in Nigerian children by Nwona et al.²¹ which study did not show any features of congenital stenotic lumbar canal in all the children investigated. The research team in Ibadan, ably led by the renowned Professor Tayo Shokunbi and in recognition of the potentials of our pioneering efforts in the area of Microtechnics evaluated *ADI-AGBON* as a clearing agent in paraffin processing of embryonic tissues (Shokunbi et al.²²) and concluded among others that *ADI-AGBON* is useful for routine work but unsuitable for quantitative histological studies. Caxton-Martins is not just limited in his research endeavours to qualitative histochemistry but forayed into quantitative histochemistry as evidenced by the interdisciplinary effort that resulted in the publication of the paper on quantitative enzyme studies of bat aorta and left ventricle²³ which findings confirmed a higher quantity of the activities of succinic-, lactate- and glucose-6-phosphate dehydrogenases in the left ventricle than the aorta of the bat which confirms that the left ventricle was highly active metabolically than the aorta.

THE B.Sc. HEALTH SCIENCES PROGRAMME

The then Faculty of Health Sciences at its inception in 1972 started with *B.Sc. (H/Sc.)* degree programme for all its medical students. The high point of this programme was that pre-clinical medical students had to submit a dissertation in partial fulfilment of the award of the *B.Sc.* degree like all other students pursuing a conventional *B.Sc.* degree programme. This enabled some of our students to be introduced into the world of science, especially through laboratory-based, basic, simple but scientific investigations which were examined and graded. This also sought to bring out the best in the teachers who supervised these students and their projects. Some such projects were so meaningfully designed that they were presented at some important scientific meetings^{24, 25, 38} whilst some were actually published^{16, 31, 32} in learned journals.

Published Theses

In the course of my career, I was put through the rigorous process of publishing dissertations based on original work in order to earn higher degrees. The first of such dissertations titled "Some histochemical studies on transitional cells in normal and irradiated guinea-pig bone marrow and in the bone marrow of the human foetus"²⁶ earned me the degree of Master of Philosophy of the University of Nottingham, in 1973, while the second, titled "Comparative cytochemistry of the haemopoietic systems of some vertebrates"³⁹ earned me the degree of Doctor of Philosophy of the University of Ife (now Obafemi Awolowo University) in 1984.

IMPACT OF HISTOCHEMISTRY - GROWTH, USEFULNESS AND PROBLEMS

Histochemistry as can be seen up to this point in time has grown from a science that was initially applied to the study of starch in plants by the botanists of the 18th century, led by the great Raspail (1794 - 1878) but has extensively been applied to the study of pigments such as iron as well as reactive groups, macromolecules, enzymes, hormones and metabolites both in plant and animal tissues. It has now grown into a formidable and highly rewarding science for the specific localization of mucosubstances and active groups by Electron-Immuno-Histochemistry techniques that is currently making the waves as research tools in modern biology. It is to be noted with the deepest regret that the modern world has left us far behind in the last decade or so. Our laboratories are no longer functional nor do we have equipment that have not now become obsolete. The average Nigerian is a very diligent, industrious and competent individual that can compare with the best from anywhere in the world. We have been there and have seen it all but never imagined that we shall see our country in this state of sagging economy, decay, insecurity and want. It is, therefore, the responsibility of all of us in this audience to make up our minds to give our country the proper orientation and direction she rightly deserves. When preparing for this discourse, I went through my library in search of the transparencies to use to illustrate some of the results I was to present. I was amazed at the quantity and quality of the transparencies that I had accumulated over the years through the able technological support of a colleague who joined the services of the University a few years after I had joined. I refer to Mr. M. Bamidele Salami, our distinguished Medical photographer. He prepared

the slides that we are able to see today. Then he was a tireless worker who toiled day and night to meet our demands. Today, consequent upon the present state of underfunding, a highly competent and hard working medical illustrationist had been reduced to a mere passport-size photographer. What a disaster? What a tragedy? Many of us had equally become redundant since as teachers of the basic and applied sciences, our laboratory outputs have been minimal. We must redirect our policies to focus on the essentials, that is, to generate growth in wealth, growth in education and so on and so on. The wealth is there in this country but what are we doing to harness it?

THE NIGERIAN POLITY, SCIENCE AND GROWTH

This is where I have a few words for our leaders. Our leadership must rededicate itself to its traditional duties and seek excellence in professionalism. Any individual that is aspiring to civil governance, should do so properly and in accordance with the provisions of our constitution. There is no reason why a member of the military or academia or judiciary should not have an ambition to head our lawfully and constitutionally elected government but such ambition must be lawfully and constitutionally realised. Permit me to relate our polity (NIGERIA) to the title of my discourse. The key words as I had earlier defined are *Histochemistry*, a scientific tool of investigation, *Growth* as increase in number and/or size and *Science* as a body of acquired knowledge. Can we in all sense of responsibility honestly assert that our polity had witnessed any growth in science or technology or engineering? These, yet, are the tools of determining, assessing and quantifying a civilised society. We must, in order to arrive in the 21st century, support and encourage the military to properly hand over to a civil, democratic government elected via the avenue of the ballot box. There must be no limit to the number of parties that can contest any election and even independent candidacy must be encouraged. Why must government or any body for that matter determine guidelines for formation and registration of political parties in a free and civil society? Just as this freedom will be allowed to pervade our society, so will it pervade our institutions at various levels. The Universities have, for some reasons that were not clear, remained shackled and so, we are currently witnessing the gradual garrisoning of the Universities by the appointments of sole administrators which is totally foreign to a healthy University culture. We must allow ourselves and our institutions a free atmosphere to

grow and grow as a normal course.

If one may ask and one should ask, what do all these translate to in the light of our experiences in the Nigerian polity in the past few years? It is necessary for the polity to grow but it is essential to sustain that growth. Most of the modest contributions to the growth of science alluded to in this discourse were carried out without a single naira from any research grant. In other words, the laboratory facilities, chemicals, reagents including the many vertebrate classes investigated were all catered for from the supplies and expense allocation to the department. And, this speaker was not the only scholar working in the department. What this boils down to is that our founding fathers at the time recognised and acknowledged the relevance of a virile and growing science to Nation building and progress.

Some Solutions To Our Problems

What is the panacea to all these problems? Our public officers and all those in positions of authority must rededicate themselves to the Nigerian State. It is not enough to call on the citizenry to tighten their belt and make sacrifices. The leadership must be honest, visionary and committed. One important problem to address and solve is the issue of *Education*. Every Nigerian *must* be educated and compulsorily too. Every village must have a functioning primary school with a secondary school in every ward of a local government.

(Phase 1): Every three to five contiguous local government areas must have a College of Education for the training and production of well-trained teachers at N.C.E. level. Every state must have two polytechnics and a College of Technology (Phase II): Each state of the federation must have a conventional Federal University. All these strategic measures cannot and should not be implemented in one year but must be phased out in such a fashion that each level of institution will complement the other. We must begin at the primary level with the advanced teachers colleges such that products of the teachers colleges will service the primary schools; the secondary schools should take off some four to five years after the first phase. The Polytechnics and Colleges of Technology will take off some eight years after commencement of Phase I. The Universities which must be conventional and are already in existence must be federally funded and in states where a state university is already in existence with a federal university, both should merge under a common management while states lacking in both must be endowed with a conventional federal university. There will, as is expected, be some problems but then

problems are meant to be solved and so shall be solved. I have picked on Education as a starting point to redressing our national malaise because education is the bedrock of national growth and development in all its spheres - Health, Economy, Science, Technology, Public Utilities and can be a cure to the corruption that has permeated the very fabric of our nation - state.

Having made the point about the need to attain the full education of any Nigerian who desired it, freely and compulsorily too, the question that I am sure will be raised is one of funding. The answer is obvious: the NIGERIAN State. Since the Nigerian State will be the beneficiary of such a laudable scheme, it must be prepared to fund it. Where will the funds come from? Evidently from the appropriate commercialisation and marketing of our God-given mineral resources. Let us focus on crude oil alone. If we market some two million barrels of crude alone everyday and at the conservative selling rate of sixteen dollars per barrel, the country will realise some thirty-two million dollars a day from crude oil alone. Simple arithmetic at a conservative exchange rate of eighty naira to the dollar shows that we can earn two thousand, five hundred and sixty million naira (2.56Billion) a day from crude. At the end of the year that translates to some nine hundred and sixty four billion naira a year.

I do not know of any country in the whole of black Africa that can realize such a whooping sum of revenue in a year and yet, just from one product alone. Others are there - BITUMEN, GOLD, MARBLE, TIMBER etc. etc. Our problem is nothing but lack of will to prosecute laudable and meaningful projects and also possibly *misplaced priorities*. Only recently, one of our very senior and highly distinguished professors in one of our first generation universities was reported to have proclaimed that the Nigerian State cannot fund education alone. I beg to differ. The state can and easily too. And unless we begin, as some other committed and patriotic individuals and institutions are doing, to persuade the leadership to consciously invest in Education for the sake of the Nation, then we are all headed for eternal DOOM.

The other time, just some months ago, I confirmed that the average policeman on the beat in England earns a take home pay of five hundred pounds a week (Twenty-four thousand pounds a year) which is something like six hundred and fifty thousand naira (N650,000.00k) in a week, here in Nigeria or Two million, six hundred and fifty thousand naira monthly take-home pay. We all marvel! yes, we ought to but that is the level of indignity and poverty that we have subjected ourselves to in our own country. Suffering in the midst of

olenty!!!

Richard Jolly, the co-ordinator of the 1997 Human Development Report affirmed that nearly one-third of the developing world's population, live on less than one dollar a day. I do not have the figures of how many Nigerians fall squarely into this category. I also have it on authority that the total crude oil reserves in the world will be used up by the year 2015 some eighteen years from now, yet we are not making any serious and conscious efforts to source for alternate forms of energy and income. Before I digressed, I was pronouncing on the way forward for our development and growth in this country and that is to concentrate on our educational institutions which will give us excellent teachers, lawyers, doctors, artisans, technologists, scientists, economists, sociologists, military officers, policemen, as well as freedom, justice and fair play which will all act concertedly to eradicate hunger, disease, ignorance, poverty and corruption from our society.

CONTRIBUTION TO THE TRAINING OF RESEARCHERS AND TEACHERS OF ANATOMY

It is apt and pertinent to ask what has been our own contribution to the training of Researchers and Teachers of Anatomy since our elevation to the post of Professor in 1992? This question is most germane and relevant to the growth of Anatomy, the growth of Teachers of Anatomy and also to the growth of our Colleges of Medicine that are saddled with the responsibilities of training and producing the relevant manpower for our Health Care Delivery Systems - Doctors, Nurses, Dental Surgeons, Physical and Occupational Therapists, Environmental Health Scientists, Laboratory Technologists, Radiologists and practitioners of other Allied Health Sciences. Thus at present we have not less than sixteen (16) Colleges of Medicine in Nigeria and some not more than forty (40) in the whole of Africa yet, I am proud to categorically and unequivocally state that GREAT IFE has the only Department of Anatomy and Cell Biology that is currently running post-graduate programmes at both M.Sc. and Ph.D. levels in the whole of the West African sub-region and prior to 1992, this speaker had participated in the training of at least five (5) of such graduate students; two of whom are still working in the department as Senior Lecturers, one is at the Department of Anatomy at Ahmadu Bello University, Zaria and two others at the Department of Nursing of this University, one of whom most regrettably, is deceased.

However, in the last three years or so, this speaker has been nurturing and guiding five (5) others, three of whom are from outside

GREAT IFE, that is, two from Ogun State University and one from University of Calabar who are pursuing studies and research leading to the award of the Ph.D., and another two who are members of staff of our own department for the Master of Science Degree. We must congratulate ourselves on several fronts!

- (i) that the Department of Anatomy and Cell Biology of this GREAT IFE is not only producing highly trained academic staff for its own consumption but also for the consumption of other sister Universities in Nigeria; and,
- (ii) that this very modest contribution will help reduce the dearth of competent and highly trained Anatomists in the country who will also be able to make their mark as teachers and researchers.

The realization that since 1960 the country has only had eight Nigerian Professors of Anatomy, two of whom are retired since 1989, three have been out of the country and only three of us are still on ground in the country is a pointer to the urgent need to increasing our efforts in training young anatomists. These three, Professors A.B. Ejiwunmi, of Ago-Iwoye; M.T. Shokunbi the nail-in-the-head Surgeon of University of Ibadan; and my humble self have weathered on to ensure that the Colleges of Medicine do not collapse and or suffer serious curricular damage and distortions in the training of Doctors, Dentists, Nurses, etc. But then the task remains herculean as we must train from our own stock the teachers that will teach our children in the Colleges of Medicine. It is for this reason that the Government must adopt the proper strategies in retaining competent staff to teach at all levels of our educational systems. The classroom environment must be conducive for learning, facilities and equipment must be available and current, support facilities like water, electricity, modern audio visual aids/communication gadgets, transportation, etc. must be available. I have had to decline invitations to serve as External Examiner to the Medical Schools in Accra, Freetown, Zaria, Calabar, etc., purely for transportation and other logistics problems preferring instead our nearer medical schools like Lagos, Benin, Ibadan, Ago-Iwoye, Ilorin and more recently Ogbomosho. Nigeria must wake up and hurry in its developmental efforts and our educational sector must henceforth receive priority attention. The likes of Philip Emeagwali - the computer guru may never reach his present enviable status had he remained in Nigeria. He was in fact, in his own account, a school dropout here in Nigeria and it took a U.S. Embassy official here in Nigeria

to recognise his potential and ease him out to the U.S.

Summary

How do all these our scientific revelations benefit the ordinary man in our society? We had earlier commented on the implications of our findings on cotton seed oil, *ororo koro owu* as capable of intervening and disrupting normal spermatogenic processes in the testis of rats. Were these findings extrapolatable to Man; and there is some evidence of this, the implication then is that the male members of our communities who ingest *Ororo Koro Owu* are indirectly and ignorantly sterilizing themselves by aborting their normal processes of production of spermatozoa. In other words, they will not be producing competent and enough spermatozoa to effect fertilization of the female gamete. The traditional custom in Yorubaland is to blame such sterility and or infertility on the innocent female partner. This, our finding also has its positive effects as we know that gossypol had been adapted successfully as a way of effecting birth/population control in China, etc. We also intimated you of our findings (Sogbamu, Ifediora and Caxton-Martins) on the cytochemistry of the leucocyte compartment in pregnancy where we confirmed the usefulness of glycogen, lipids and peroxidase values as prognostic indices in regard to foetal well being and birth weight. Sometimes in June of this year, the whole country was in ecstasy celebrating the African CHILD's Day. While the celebrations were on, with all manner of informed and uninformed speeches, we were quietly and soberly uninformed that:

- (a) in Nigeria, 140 out of 1,000 born children die before the age of 1, and 191 out of 1,000 die before their 5th birthday;
- (b) 20% of successfully delivered babies weigh below the average birth weight of 2.5kg; and
- (c) 40% of girls and 50% of boys are stunted at birth.

Our prognostic indices now become more useful in determining the foetal well being and birth weight especially during the third trimester of pregnancy to alleviate such pathetic situations. Enough of our contributions to the health status of our communities. In the area of economy, our pioneering efforts in using our locally available resources such as *Adi Agbon*, *Elo Aku* and *Inya* have considerable economic potentialities as they can be properly processed, commercialised and exported to the world. They all have considerable advantages over the

conventional products as they are non-toxic, non-carcinogenic and comparatively cheaper to source and use.

Mr. Chairman Sir, distinguished Ladies and Gentlemen, this has been our very modest insight into HISTOCHEMISTRY AS A GROWING SCIENCE and our contribution to the centre of EXCELLENCE which this our great institution, The GREAT IFE has become. Permit me to end with this famous tonic of mine, handed down to me by my great illustrious mother Chief (Mrs.) MODUPEOLA CAXTON-MARTINS (Deceased) ably supported by my energetic and highly inspiring sister, Ms. F. Omolara Caxton-Martins and my most understanding wife, ABIMBOLA,

"Nisi Dominus, Aedificaverit domum"

"Unless the Lord builds, the builders labour in vain".

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Permit me to end with this poem by Glick (1985)⁴.

*We've come from lands around the world
In common cause to learn anew
Diversities among us should
Increase our own perceptions and
An understanding of each other.
There is no difference between
Our aims or resolution to
Advance the knowledge we all seek
Which brings us close together in*

Appreciation and respect
 And friendship that soar far above
 All man-made lines that mark
 The geographical
 Divisions separating us.
 Our work can lead to common trust
 In world's unbounded and without
 Restrictions to impede the way
 To those horizons we pursue
 Of human good for peoples all.

I thank you all for your patience.

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