MACROPHAGES, MAN AND THE ENVIRONMENT: MY LIFE'S STORY

AN INAUGURAL LECTURE,
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UNIVERSITY OF IBADAN

MACROPHAGES, MAN AND THE ENVIRONMENT: MY LIFE'S STORY

An inaugural lecture delivered at the University of Ibadan

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By

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The Vice-Chancellor, Deputy Vice-Chancellor (Administration), Deputy Vice-Chancellor (Academic), The Registrar and other Principal Officers, Provost of the College of Medicine, Dean of the Faculty of Veterinary Medicine, Deans of other Faculties and Postgraduate School, Dean of Students, Distinguished Ladies and Gentlemen.

Preamble

An inaugural lecture is an opportunity for a newly-promoted Professor to give details of what has made him/her to get to that stage of his/her academic and research career and to stand before an august gathering such as this to give some details of how he/she came about the same. On 01 October, 2006, I was pronounced a Professor of Veterinary Pathology of this great and Premier University in Nigeria having been found eminently worthy of such distinction. This makes almost nine years since then.

First and foremost, I would like to give thanks to God Almighty, the Creator of Heaven and Earth, my Alpha and Omega for deeming me fit and healthy to stand before you today to give this lecture and for the Dean, Faculty of Veterinary Medicine, Professor Matthew Olugbenga Oyeyemi for nominating me to deliver the lecture on behalf of our great Faculty this year.

Mr. Vice-Chancellor, Sir, this is the 35th inaugural lecture from the Faculty of Veterinary Medicine and the 5th from the Department of Veterinary Pathology since its establishment in 1970. The first inaugural lecture from the Department was delivered by Professor Turner Teminipre Isoun on Thursday, 19 May, 1977 with the title "Animal Protein Malnutrition and the Science of Disease"; the second was delivered by Professor Basil Orioghae Ikede on Thursday, 13 May, 1982 with the title "Living and Dying in Creatures Great and Small", and the third was delivered by Professor Victor Onwubalili Anosa on Thursday, 16 May, 1987 with the title "Trypanosomes, Man, Animal Protein and Disease. The

fourth was delivered by Professor Stephen Owarioro Akpavie on Thursday, 07 February, 2008 with the title "Animal Disease Patterns and Protein Supply in Nigeria". Mine is the fifth in the series from our department.

The Vice-Chancellor, distinguished ladies and gentlemen, you will notice that the phrases "Animal Protein", "Disease", and "Living and Dying" are common denominators in all of these previous lectures. The title of my lecture today – Macrophages, Man and the Environment: My Life's Story (not a typical auto-biography), may seem out-of-place, but surely encompasses all these *"pathology phrases"* and further elucidates why animals, humans and our environment get sick and die because of what Man (and the Macrophage) do or do not do as "divine, *God-given*, keepers" of their respective environments, and how I got myself involved.

About 32 years ago, after graduating with a D.V.M degree (with Distinctions in Veterinary Pathology, Clinical Pathology and Public Health and Preventive Medicine), from this great Institution, I had an option of quietly returning to Ogun State as a career civil servant/veterinary doctor or continuing with academics. I was successfully lured into the Department of Veterinary Pathology, first as Youth Corper and later as Temporary Lecturer II in 1984 and 1986, respectively, by the combined efforts of my academic fathers and mentors, Professor Basil Orioghae Ikede and Professor Victor Onwubalili Anosa, because of my brilliant performance in the subject area of Veterinary Pathology. Between these two giants and under their tutelage, I was nurtured and to be what I am today, *a proud and fulfilled Pathologist*. More information on this shall be given later.

Mr. Vice-Chancellor, many people, including the educated and the learned often think, or believe and say that Pathologists are ONLY concerned with the DEAD. Nothing can be farther from the reality. It is absolutely true that Pathologists perform post-mortems on dead animals, which not only determines the animal's cause(s) of death, but also discover more information about the cellular, ultra-structural

and molecular progression of an on-going disease, proffer advice on its mitigation to the clinician and offer advice on its ultimate prognosis. A pathologist also examines tissue biopsies to determine if they are benign growths and shares the information with the clinician. He may also recommend what can be done to prevent illness and maintain good health. For example, when blood is drawn, or biopsy is taken, as part of routine physical and/or medical examination, the pathologist supervises and performs the tests to help assess the patient's state of health. That is why the subject, Pathology, is at the core and centre of Medicine.

Mr. Vice-Chancellor, distinguished ladies and gentlemen, you may not hear much about death or such things from me today, but about what may lead to or prevent it. Let me now proceed to give you a treatise on each of the tripod of my lecture today, viz. Macrophage, Man and the Environment, the basis of my talk today, and I will later go on to reveal how I got myself involved with them.

Introduction

The Macrophage

The macrophage (fig. 1), is a bone marrow-derived mononuclear cell (Gordon and Taylor 2005) that circulates in the blood as peripheral blood monocytes (PBM), can engage in pinocytic and phagocytic activities or those that have "homed" into tissues/organs in the steady state or in response to inflammatory or disease conditions (van Furth et al. 1985), and various chemotactic factors resulting in macrophage populations that are referred to as resident macrophages. Macrophages are about the largest, most versatile and widespread group of cells in the body.

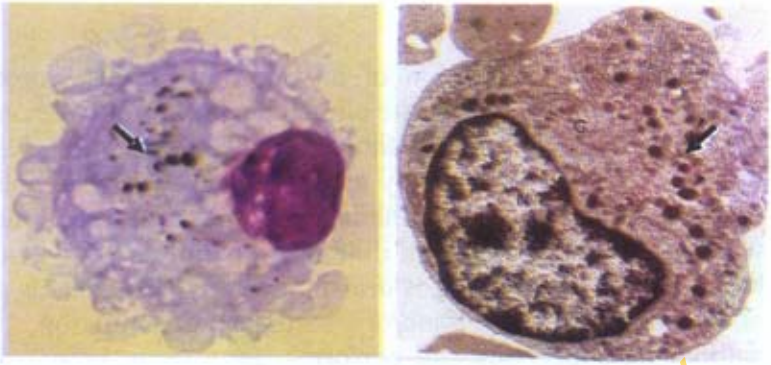

Fig. 1: A Giemsa-stained macrophage (left) containing engulfed particles (arrows), with typical bluish-grey foamy cytoplasm and equally foamy nucleus. Another at TEM (right) with abundant cytoplasm and engulfed particles (Courtesy: Zucker-Franklin et al. 1988).

Resident macrophages can be found in many tissues and organs, including connective tissue, liver, lung, lymph nodes, spleen, bone marrow, serous fluids, skin and others where they assume specialized forms, characteristics and functions table 1 and figure 2 show the various types of macrophages and their names in many organs and tissues. Some types of macrophages identified either by expression of distinct surface receptors/markers or by discrete secretory products, may be associated with distinct disease states.

Table 1: A List of Different Types of Macrophages with Different Names in different Tissues and Organs in the Body

Adopted Macrophage Name	Tissue/Organ Location
Monocyte	Bone Marrow/Blood
Adipose tissue macrophages	Adipose tissue
Kupffer cell	Liver
Sinus histiocytes	Lymph node
Alveolar macrophage(dust cell)	Lungs
Tissue macrophage (Histiocyte)	Connective Tissue
Langerhan's cell	Skin and Mucosa
Microglia	Central Nervous System
Hofbauer cell	Placenta
Intraglomerular mesangial cell	Kidney
Osteoclasts	Bone
Epithelioid cells	Granulomas
Red Pulp Macrophage (Sinusoidal lining cells)	Red pulp of Spleen
Peritoneal macrophages	Peritoneal cavity

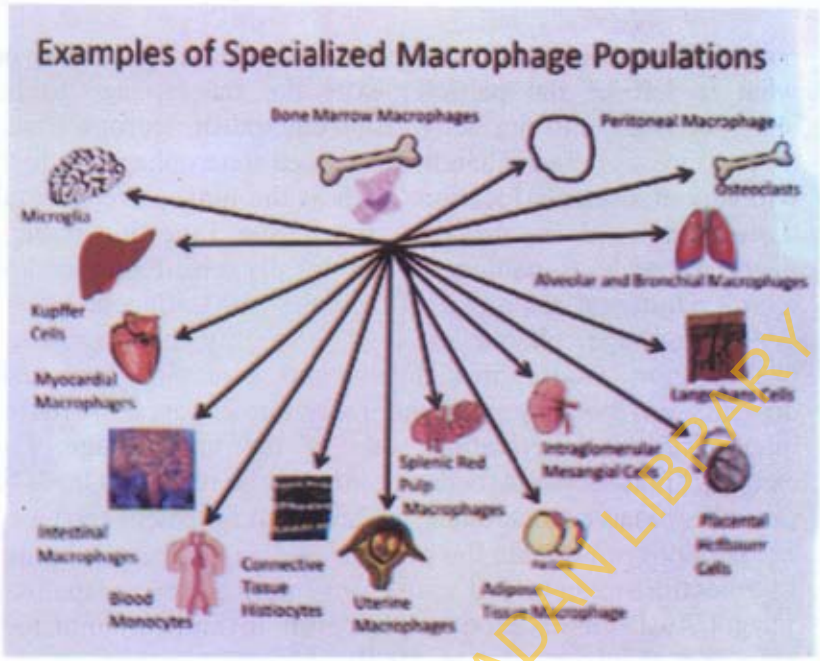

Fig. 2: Graphical representation of locations, names and associated functions of macrophages in the human body (adapted from Dietert 2014).

Multinucleated giant cells are derived by fusion of macrophages and have the capacity to function like macrophages in host defence against infections, especially chronic infections. They are also engaged in the removal of large foreign objects inhaled into the lungs.

Functions of Macrophages

(a) Phagocytosis

One important role of the macrophage is the removal of necrotic and other cellular debris in the tissues and organs by phagocytosis. Removing infectious agents, dead and unwanted cell or particulate materials is important in chronic inflammation, as the early stages of inflammation are dominated by neutrophils (also known as microphages), which are ingested and destroyed by macrophages when they

come effete (worn-out or aged). The remaining debris, or what is left of the particle, exits the macrophage to be absorbed back into the body. The removal of necrotic tissue is, to a greater extent, handled by fixed macrophages, which will stay at strategic locations such as the lungs, liver, neural tissue, bone, spleen and connective tissue, ingesting foreign materials such as pathogens and locally proliferate and/or recruit additional macrophages from the PBM, if needed.

Macrophage phagocytosis is a highly heterogeneous phenomenon whose mechanism and biological outcome depends on the nature of the receptors engaged, particles internalized and activation state of the macrophage. For example, phagocytosis mediated through Fc receptors leads to pro-inflammatory outcomes, whereas complement-mediated uptake does not initiate the same responses. Unlike the uptake of infectious agents that cause pro-inflammatory responses, phagocytosis of apoptotic cells result in anti-inflammatory responses (Morrissette et al. 1999).

Macrophages are prodigious phagocytic cells that also clear approximately 2×10^{11} erythrocytes each day (see fig. 3). This equates to almost 3 kg of iron and haemoglobin per year that is 'recycled' for re-use by the host (Mosser and Edwards 2008). This clearance process is a vital metabolic contribution of the macrophage without which the host would not survive. This activity is typified by the presence of erythroblastic islands in the active bone marrow, consisting of a central Nurse Cell surrounded by developing erythroblasts.

Fig. 3: SEM of Bone-marrow-derived macrophages phagocytising IgG-coated red blood cells (Courtesy: J. Swanson and M. Diakonova; in: Morrissette et al. 1999).

Nurse cells are specialized macrophages (fig. 4) residing in the bone marrow that assist in the development of red blood cells (Zucker-Franklin et al. 1988). They absorb the extruded nuclei (haematogon) of immature red blood cells (late normoblasts) and iron and provide growth factors to help the red blood cells mature. In the bone marrow, immature red blood cells (erythroblasts) can be seen grouped in a cluster around a nurse cell.

In the course of some disease conditions, such as in haemoprotozoan diseases like trypanosomosis and malaria, macrophages in the bone marrow are involved in wanton phagocytosis and destruction of immature red blood cells, and white blood cells as well, leading to ineffective erythropoiesis, dyshaemopoiesis and anaemia (Jain 1986; Taiwo and Anosa 2000).

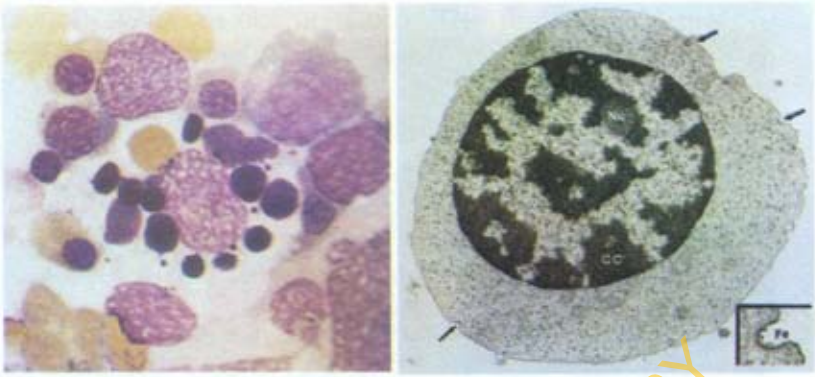

Fig. 4: Left, a macrophage "nurse cell" with engulfed mature and immature red cells, surrounded by developing erythoblasts. Right is TEM of nurse cell with cytoplasmic blebs corresponding to Fe transfer points (arrows and inset) to developing erythroid cells (Zucker-Franklin et al. 1988).

(b) Immune Response

Macrophages constitute an important link between the innate and adaptive immune systems through processing and presentation of antigens (fig. 5) to T-cells and production of cytokines and chemokines. The capacity of macrophages to participate in these and other processes by directly or indirectly influencing the bioactivities of other cells may depend on the developmental stage and cell activation. Macrophages take part in all phases of body's immune response (both cytotoxic and antibody-mediated) as phagocytic cells, and functionally distinct macrophage populations provide for very flexible immune responses. They also play key roles in host defences against intracellular parasitic microorganisms and tumour cells.

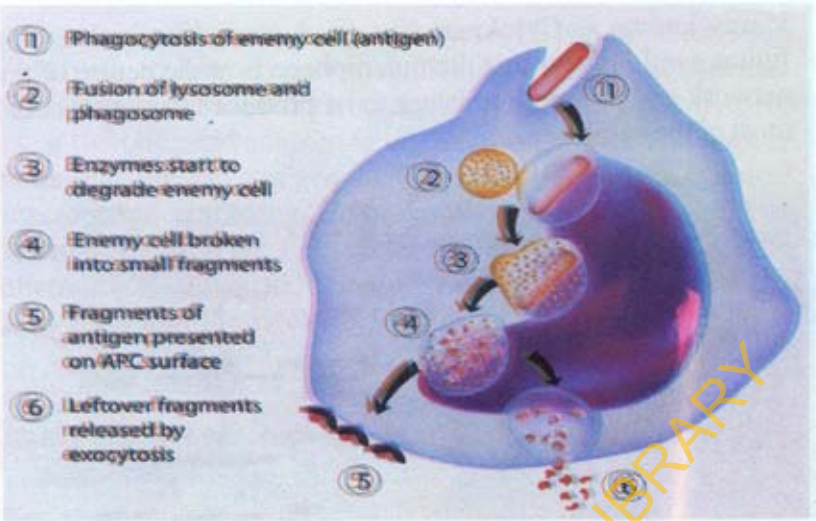

Fig. 5: Schema of antigen processing and presentation by a macrophage (courtesy: www.AlilaMedicalMedia.com).

(c) Wound Healing

Tissue macrophages play a critical role in wound healing by producing chemo-attractants that recruit and activate additional macrophages from nearby tissues and blood, growth factors that promote cellular proliferation, proteases and extracellular matrix molecules, and other factors that restrain tissue growth once repair is completed. IL-4 is very important in this regard, as it stimulates arginase activity in macrophages, allowing them to convert arginine to ornithine, a precursor of polyamines and collagen, thereby contributing to the production of the extracellular matrix (Kreider et al. 2007).

Macrophage and the Cytokine Network

The immune system recognizes the presence of pathogens by several proteins that bind to molecules secreted by the pathogens or carried on their surface. The cells responsible for these immune responses include the B-Cells, T-Cells, macrophages, neutrophils, basophils, eosinophils, endo-thelial cells and mast cells. These cells produce a series of products

jointly known as Cytokines (fig. 6). A very close look at this figure would reveal that the macrophage is at the centre of the network and produces or cause to be produced (by other cells) most of the cytokines.

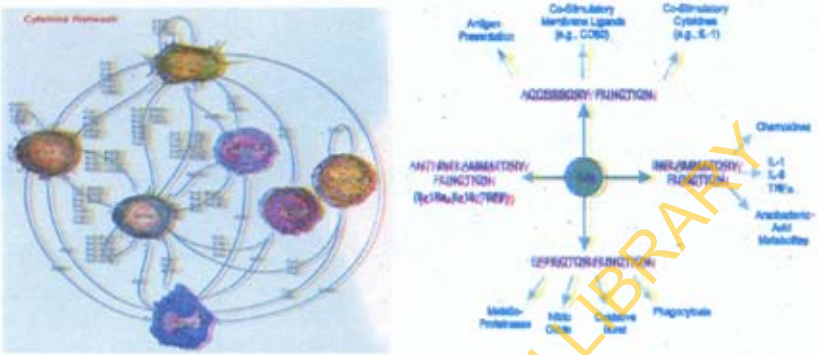

Fig. 6: The Cytokine Network (left) with the macrophage at the centre (right) with varying roles in homeostasis, immune response and inflammation (adapted from *QIAGEN-GeneGlobePathways.htm*).

Cytokines have been classified on the basis of their biological responses into pro- or anti-inflammatory cytokines, depending on their effects on immunocytes. Cytokines act in networks or cascades. Major cytokines include the interleukins (ILs), growth hormone, interferons (IFN) and tumour necrosis factors-alpha (TNF-α) and beta (TNF-β). Many of the cytokines act locally like autocrine hormones and their targets are cells of the same or similar type as the cytokine-producing cell. A characteristic that significantly differentiates some of the cytokines from hormones is the coupling of their activity to cell-cell interactions.

Macrophage Activation

A number of research groups have advocated sub-classification of the activation states seen in recruited macrophages, broadly into M1 and M2, or classically-activated and alternatively-activated, respectively (Mantovani et al. 2002; Gordon 2003). Classical macrophage activation

refers specifically to the broad class of activation observed in response to challenge by microorganisms. Classically-activated macrophages are strongly positive for class II-MHC, and adapted to kill microorganisms and tumour cells and present antigen to T lymphocytes. The classical macrophage activating factor, produced by stimulated Th1 lymphocytes and NK cells, is interferon-gamma (IFN-γ). The alternatively-activated macrophage is associated with Th2 activation and the cytokine, IL-4 (Gordon 2003); see figure 7.

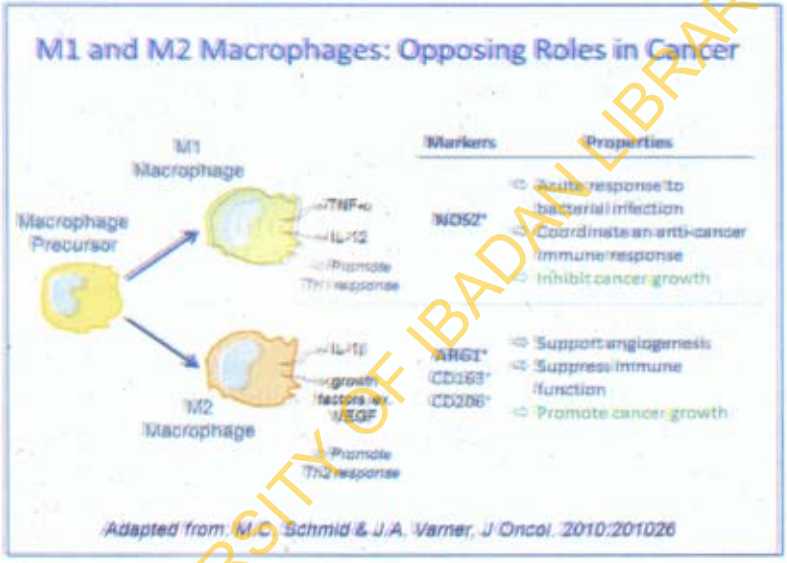

Fig. 7: Classification of macrophages according to functional and secretory diversity and roles in cancer (adapted from Schmid and Varner 2010).

Macrophage populations have been shown to comprise distinct subpopulations that are being referred to generally as polarized macrophages. The term classically activated macrophages (also called M1 macrophages) refers to macrophages that have undergone activation in response to lipolysaccharide (LPS) or gamma interferon). Classical M1 macrophages have a pro-inflammatory phenotype and are characterized by high expression of pro-inflammatory

cytokines, iNOS expression, and production of reactive oxygen species (Gordon 2003; Gordon and Taylor 2005; Martinez et al. 2008, 2009). More generally speaking, activation of macrophages by Th1 cytokines (which includes IFN-γ and TNF-α) is referred to as type 1 activation (Gordon 2003). The cytokines expressed by M1 macrophages such as IL-1β, TNF-α, IL-12, IL-6 are sometimes referred to as M1 cytokines.

The term alternatively activated macrophages (also called M2 macrophages) refers to macrophages having undergone cell activation in response to IL-4 or glucocorticoids (Gordon 2003; Martinez et al. 2008). These cells have an anti-inflammatory phenotype. More generally speaking, cell activation of macrophages by Th2 cytokines (which includes IL-4 and IL-13) is referred to as type 2 activation (Ma et al. 2003). Alternatively activated macrophages generated *in vivo* have a gene expression profile distinct from other macrophage populations (Zhang et al. 2010). The cytokines expressed by M2 macrophages, such as IL-10, IL-1ra, TGF-β are referred to sometimes as M2 cytokines.

Like the Th1/Th2 dichotomy, the M1/M2 distinction blurs on the boundaries when one compares distinct types of stimulus and individual cells. A more credible and sustainable view could be explained as a range of macrophage phenotypes in a spectrum of colours on a colour wheel (fig. 8). Macrophages could be classified as "red", "yellow" and "blue", but every combination and shade is possible and they can be inter-converted. This kind of plasticity may ensure that the number of "subsets" than can be defined is infinite: ***a function of the number of markers and the micro-environments where the macrophages are found.*** These cells thus can display a range of functional and morphological phenotypes (expression of membrane-bound receptor and secretory products). Mosser and Edwards (2008), have reviewed the biology of different subpopulations of macrophages and have suggested a macrophage classification scheme based on the fundamental macrophage functions that are involved in maintaining homeostasis.

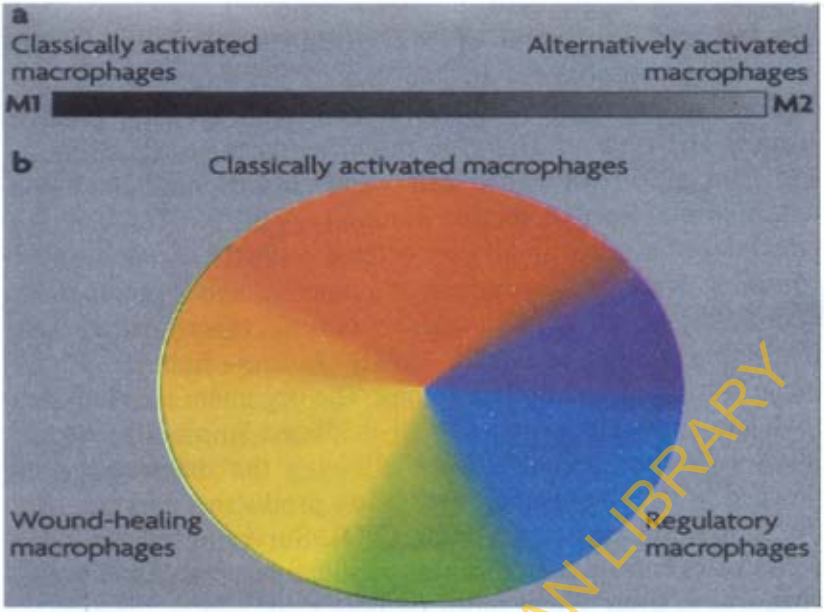

Fig. 8: Colour wheel of macrophage activation as proposed by Mosser and Edwards 2008.

The "Bad" Macrophage: A Host for Intra-Cellular Pathogens and a "Permissive Agent" For Diseases

Macrophages are also known to ***antagonize immune responses or become permissive for infectious agents and disease process to fester and hide infectious agents from the defence system of the body***. In their role as phagocytic immune cells, macrophages are responsible for engulfing pathogens to destroy them. Some pathogens subvert this process and instead live inside the macrophage, thus providing an environment in which the pathogen is hidden from the immune system and allows it to replicate. Diseases with this type of behaviour include tuberculosis, leishma-niasis, human immunodeficiency virus infection, Ebola virus disease, cancer, among others. I will now briefly talk about each of these diseases.

(a) Tuberculosis

Mycobacterium tuberculosis (MTB), the cause of tuberculosis in man and animals, is among the microorganisms most

successful at adapting to long-term residence in macrophage phagosomes. Inhalation of MTB leads to phagocytosis by alveolar macrophages. In the advanced stages of myco-bacterial infection, the host immune system tends to change from a Th1-type to Th2-type immune response, resulting in the abrogation of Th1 cell- and macrophage-mediated antimicrobial host protective immunity. This type of immune conversion is occasionally associated with the generation of certain types of suppressor macrophage populations (Tomioka et al. 2012). Also, before macrophages are immunologically activated, MTB blocks maturation of phagosomes into phagolysosomes. The organism continues to replicate until the onset of cell-mediated immunity, which involves elaboration of IFN-γ, allowing the macrophage to proceed with phagosomal maturation producing microbicidal molecules, such as nitric oxide (NO). Surviving bacteria are believed to enter a period of non-replicating persistence in the phagosome until the waning of host's immunity leading to reactivation from the latent state and the onset of disease. Thus, adaptation of MTB to the phagosomal compartment of the macrophage is an essential component of its pathogenesis, transmission and continued survival as a life form.

(b) Leishmaniasis

Upon phagocytosis by a macrophage, the *Leishmania* parasite finds itself in a phagocytic vacuole. Under normal circumstances, this phagocytic vacuole would develop into a phagolysosome and its contents would be digested. *Leishmania* alters this process and avoid being destroyed; instead, it makes a home inside the vacuole (Tomioka et al. 2012).

(c) Human Immunodeficiency Virus Infection

Macrophages also play a role in Human Immunodeficiency Virus (HIV) infection. Like T cells, macrophages can be infected with HIV, and even become a reservoir of ongoing virus replication throughout the body. HIV can enter the

macrophage through binding of gp120 to CD4 and second membrane receptor, CCR5 (a chemokine receptor). Both circulating monocytes and macrophages serve as reservoir for the virus (Tomioka et al. 2012).

(d) Ebola Viral Disease

Ebola hemorrhagic fever is a severe viral infection characterized by fever, shock and coagulation defects (Bray and Geisbert 2005). The disease has a very high case of fatality rate (Wahl-Jensen et al. 2011). The recent and on-going Ebola epidemic in West Africa is the worst in the history of the neglected disease, with more than 26,600 cases and almost 11,000 deaths so far (CDC 2014). Studies in macaques show that major features of the disease are caused by effects of viral replication in macrophages and dendritic cells (Wahl-Jensen et al. 2011). Following infection, monocytes and macrophages are among the first cells targeted by the virus. These cells respond by increasing expression of pro-inflammatory cytokines and chemokines that contribute towards pathogenesis. Infected dendritic cells also secrete pro-inflammatory mediators, but cannot initiate antigen-specific responses (Bray and Geisbert 2005). As a result of this, the virus disseminates between macrophages and other cell types throughout the body, causing multifocal necrosis and a syndrome resembling septic shock. Massive "bystander" apoptosis of natural killer and T cells further impairs immunity (Bray and Geisbert 2005).

(e) Cancer

In cancer during the neoplastic progression, macrophages as well as dendritic and NK cells are attracted into the tumour site and initiate the immune response against transformed cells. They activate and present tumour antigens to T cells, which are then activated to kill tumour cells. However, tumour cells are often capable of escaping the immune machinery. It is notable that tumour-associated macrophages promote the proliferation of tumour cells directly by secreting

growth factors and proteins that stop apoptosis and promote cell proliferation and inflammation (Lamagna et al. 2006). They also participate in tumor progression by acting on endothelial cells and thus promoting the neo-vascularization of the tumor.

Macrophages are also known to play inglorious roles in the pathogenesis and severity of other conditions such as obesity, heart diseases and diabetes mellitus, which time and space will not allow me to dwell on at this lecture. Concluding on Macrophages, Vice-Chancellor, Sir, it is not far-fetched from the fore-going to tag the Macrophage as a "divinely appointed cell" given the role of protecting and maintaining homeostasis in man and animals; though they also play eminent roles in suppressing immune responses and even covertly exacerbating the disease processes and outcomes in animals and man. The definitions of the many functional phenotypes of macrophages may have scientific and diagnostic value, but the perspective should be maintained that macrophages ***are not static*** and that the functional and phenotypic changes occurring during inflammatory and/or immune responses may not be differentiation into stable, defined, functional phenotypes ***but an evolving shift of functional activities in response to a changing environment*** (fig. 9).

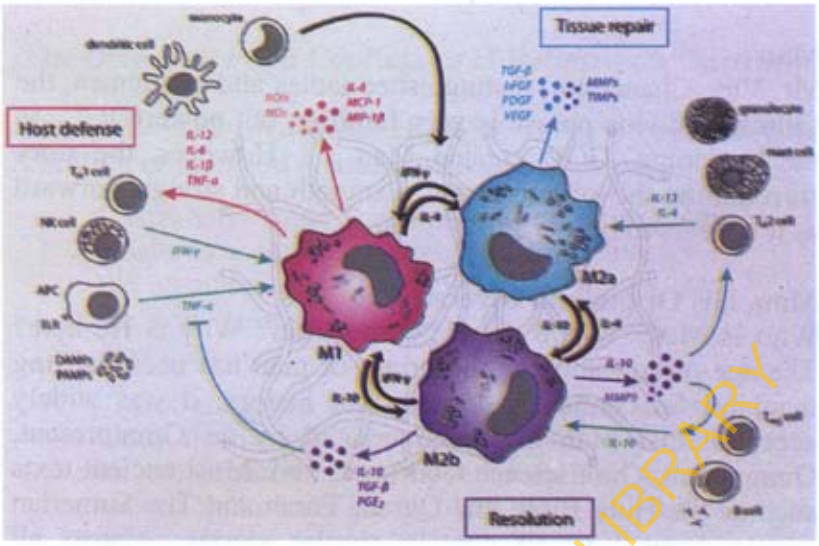

Fig. 9: The shifting roles of the macrophage under changing "environmental" conditions (Courtesy: Tomioka et al., 2012).

In this context, defining macrophage subsets by membrane protein and functional phenotype during inflammatory and/or immune episodes might be akin to defining chameleons by the colour pattern they display as they move across an artist's paint palette (fig. 10).

Fig. 10: Chameleon: Any shade or colour combination goes.

Man

Mr. Vice-Chancellor, distinguished ladies and gentlemen, the following divine phrase is very familiar, but powerful: "... in the beginning, GOD created Man ...". However, the story surrounding this phrase is not as smooth and straight-forward as it appears to be.

Man, His Origin and Diversity

Who is Man? Where did He come from? Why is He here? The age-old question of the origin of man has been baffling mankind for centuries. For most of history, it was widely accepted that Man had been created by an Omnipresent, Omnipotent, Omniscience God (or Gods). Most ancient texts such as the Holy Bible, the Quran, Torah and The Sumerian tablets seemed to all contain similar stories. Almost all religions are based on this God/creation premise in some form or another. It wasn't until the mid 1800's when Charles Darwin introduced his Theory of Evolution.

Charles Robert Darwin (12 February, 1809 - 19 April, 1882) said Evolution is a slow gradual process. He wrote:

> ...Natural selection acts only by taking advantage of slight successive variations; she can never take a great and sudden leap, but must advance by short and sure, though slow steps. ...

Darwin's theory questioned the Creation Theory, and since then the "battle" between religion and science began. Darwin's theory, while scientifically sound, still leaves many questions unanswered: "Why the vast appearance and chromosomal differences between cromagnon and Homo sapiens?" "How did modern man seemingly just "appear" out of nowhere, wearing clothing and organizing societies (intelligent)?", "What is the "missing link"?" "Which is the truth? Science, Religion or a combination of both?" and "Why are there different races of humans?"etc...

The Divergence and Confluence of Religion and Scientific Creationism

The Holy Bible in Genesis 1:24-29 (NIV) accounts for the Creation of Man and Animals (domestic and wild):

> [24] And God said, "Let the land produce living creatures according to their kinds: the livestock, the creatures that move along the ground, and the wild animals, each according to its kind." And it was so.
>
> [25] God made the wild animals according to their kinds, the livestock according to their kinds, and all the creatures that move along the ground according to their kinds. And God saw that it was good.
>
> [26] Then God said, "Let us make mankind in our image, in our likeness, so that they may rule over the fish in the sea and the birds in the sky, over the livestock and all the wild animals, and over all the creatures that move along the ground."
>
> [27] So God created mankind in his own image, in the image of God he created them; male and female he created them.
>
> [28] God blessed them and said to them, "Be fruitful and increase in number; fill the earth and subdue it. Rule over the fish in the sea and the birds in the sky and over every living creature that moves on the ground."
>
> [29] Then God said, "I give you every seed-bearing plant on the face of the whole earth and every tree that has fruit with seed in it. They will be yours for food.

All underlines are mine, and for emphasis.

From the foregoing, one must ponder and realize that:

- man and animals were created separately by God, so we are very sure that man did not evolve from apes as what evolutionarists would like to make us believe
- man was created by God as superior to animals. In fact, God purposely made man to rule over all animals on earth
- man was created by God in His own image, points to the fact that God created man for a certain purpose
- man did not just come about to live here on earth without any reason

Yes, there is a divine plan conceived by the Almighty God, for the Creation of Man.

For purely academic reasons, let us have a cursory look at some of the points at the other side of Creation in order to arrive at plausible courses and causes of Man's racial and language diversities.

There are at least three hypotheses proposed for the Origin of Man, as described by Richard Deem (2006) in a Lecture titled "Origin of Mankind and the Races". The first one is based on the Classical Hypothesis that stated that Man evolved from a series of *Homo* species (*Homo ergaster* and *Homo antecessor*) into Neanderthals (*Homo neandertalensis*, formerly *Homo sapiens neandertalensis*), which gave rise to modern humans (*Homo sapiens*). This evolutionary hypothesis is no longer considered to be valid by scientists (Deem 2006; fig. 11). The second is based on the fact that Man "***originated from Africa***". This evolutionary hypothesis states that modern humans arose from *H. neandertals* or other species of the genus *Homo* (*Homo antecessor*, *Homo ergaster*) (fig. 11). The Neanderthals lived between 150,000 and 29,000 years ago in Europe and Western Asia.

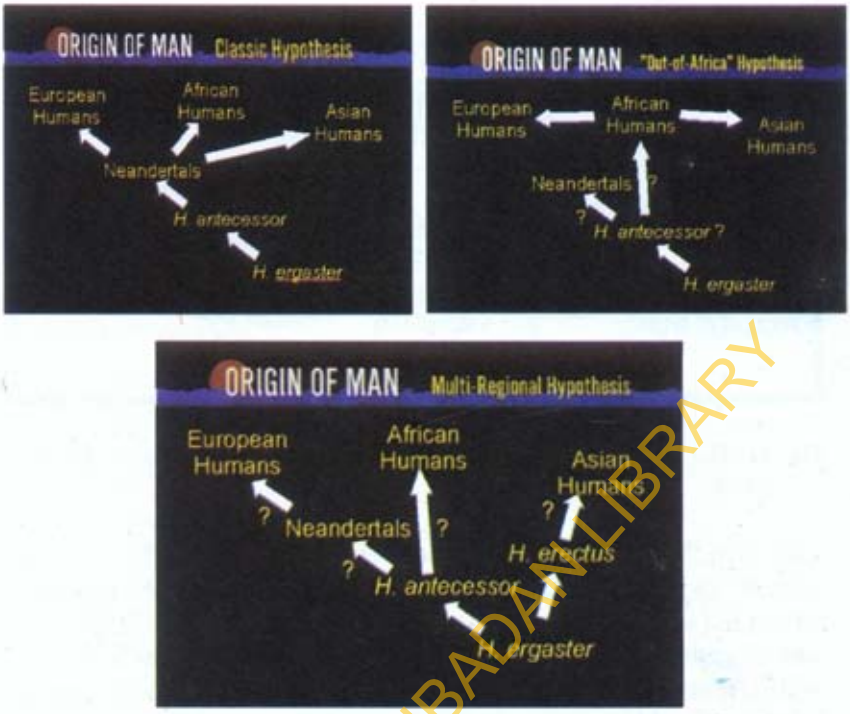

Fig. 11: Hypotheses for Creation of Man (Deem 2006).

Geographically and chronologically, their existence overlapped with that of modern humans. They are similar to modern humans in that they are bipedals and have large brain capacity. But they differ from modern humans in that they have elongated foramen magnum, medial pterygoid tubercle and a flatter skull base (fig. 12). Deem (2006) summarised that Neandertals have no genetic (nor evolutionary) connection to humans and that Neandertals displayed limited genetic diversity.

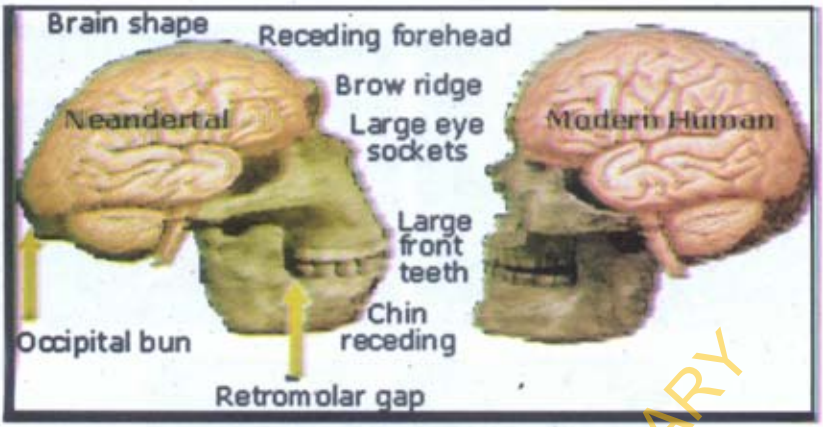

Fig. 12: The skull and brain of Neandertals vs. the modern human's (Deem 2006).

The third, **Multi-regional Hypothesis**, is similar to the *"Out of Africa"* hypothesis but that *H. ergaster* gave rise to *H. erectus*, which led to emergence of Asian humans. It also averred that *H. Antecessor*, from H. *ergaster*, gave rise to African humans; while *H. neandertals*, from *H. antecessor*, gave rise to European humans (fig. 11).

However, there is a fourth one, the Biblical Hypothesis (the Creation Model) which asserts that all men came from Adam and Eve (fig. 13).

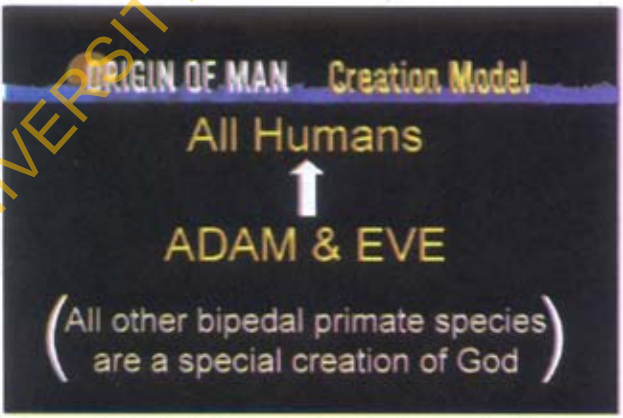

Fig. 13: The Creation Model (Deem 2006)

According to Wallace (1864), there is however, one enquiry:

> Are the various forms under which man now exists primitive, or derived from pre-existing forms; in other words, is man of one or many species?

To this question we immediately obtain distinct answers diametrically opposed to each other: one party positively maintaining that;

> Man is a species and is essentially one; that all differences are but local and temporary variations, produced by the different spiritual, physical and moral conditions (THE ENVIRONMENT) by which he is surrounded.

the other party maintaining with equal confidence that

> Man is a genus of many species, each of which is practically unchangeable, and has ever been as distinct, or even more distinct, than we now behold them.

In my own opinion, and by my religious leaning and available incontrovertible scientific proofs, which I strongly believe, the Creation Model fits the available scientific data better than any of the evolutionary models for the *Origin of Man*. The Bible describes the **Creation of Man** as having occurred in the Mesopotamian Plain, near the Tigris and Euphrates Rivers (fig. 14);

> Genesis 2:10, 14: Now a river flowed out of Eden to water the garden; and from there it divided and became four rivers. And the name of the third river is Tigris; it flows east of Assyria. And the fourth river is the Euphrates.

Fig. 14: The Mesopotamian Plain (adapted from Deem 2006).

According to the Bible, ***Man has been directly created by God***. All the evolutionary concepts are held up in a materialistic matrix and are therefore logically insufficient for the explanation of the origin of Man. Since "breeds" of men seem to be perfectly fertile when crossed, it may be said simply that there is only a single human species, whose origin is from one source – God.

Human Diversity (Races) and Language

It is widely known that "man begets man", whether in homogenous or heterogeneous societies, and this is the origin of mixed-blood, multi-racial humans (fig. 15). This means that any production of variations in man cannot hold, because, unless the biologists are wholly wrong, variation arises only in response to environmental diversity.

Fig. 15: Man: Multi-racial and heterogeneous.

Many of the characters which are popularly regarded as race characters seem to be merely examples of this direct adaptive response to environmental conditions. People whose ancestors have been living in the same geographic area for a long time tend to show similarities in visible characteristics such as size and shape, skin colour, and hair form, and also invisible characteristics such as blood groups.

Human "racial" diversity is a result of people in a geographic area inter-marrying, being exposed to a number of biological processes, and adapting slowly to local environ-ments. These biological processes include combining and recombining inherited genetic material over generations. This produces offspring and descendants who differ from their parents and ancestors. The environment may favour certain characteristics, producing populations that are on the average taller, or darker, or more rugged than other populations from other geographic areas. However, isolation and inbreeding within and between some populations may produce differences as well. These natural processes occur in humans as well as other animals and are the source of much study in biology and anthropology.

The Vice-Chancellor, Sir, in God's original command shall we find the original reason for human diversity;

> And God blessed them; and God said to them, "Be fruitful and multiply, and fill the earth..." Genesis 1:28

God re-issued His command:

> and as for you, be fruitful and multiply; Populate the earth abundantly and multiply in it. Genesis 9:7

The same is true of diversities in human language. The scattering of the world's people and the Biblical event at the City of Babel gives credence to God's deeds on man's language diversity (Genesis 11: 1, 4-8; AMP)

> [1] And the whole earth was of one language and of one accent and mode of expression.
>
> [4] And they said, Come, let us build us a city and a tower whose top reaches into the sky, and let us make a name for ourselves, lest we be scattered over the whole earth.
>
> [5] And the Lord came down to see the city and the tower which the sons of men had built.
>
> [6] And the Lord said, Behold, they are one people and they have all one language; and this is only the beginning of what they will do, and now nothing they have imagined they can do will be impossible for them.
>
> [7] Come, let Us go down and there confound (mix up, confuse) their language, that they may not understand one another's speech.

[8] So the Lord scattered them abroad from that place upon the face of the whole earth, and they gave up building the city.

Some scientific creationists, however, have a simple, Scriptural explanation for human diversity. According to biblical history, they said all people today are descendants of the sons of Noah. The three children of Noah, Ham, Shem and Japheth and their descendants moved to different parts of the world (Genesis 4-6), where according to the scientific creationists, normal processes producing genetic variation produced the diversity of races and nations we see today. It was averred that Shem founded the Hebrews; Japheth gave rise to the other Semites, Europeans, and the people of India (Indo-Europeans); and Ham was the father of the rest of humanity (the "coloured" peoples, as one of the scientific creationist writers puts it).

Below is the scientific classification of human races:

- African (groups indigenous to Africa)
- Caucasian (European populations)
- Greater Asian (Mongols, Polynesians, Micronesians)
- Amerindian (North and South American Indians, Eskimos)
- Australoid (Australia, Papua)

Within Africa alone are over 6,000 ethno linguistic groups, and the list is inexhaustible. Nigeria, Africa's most populous country, is composed of more than 250 ethnic groups and over 370 linguistic groups; with the most populous and politically influential being: Hausa and Fulani 29%, Yoruba 21%, Igbo (Ibo) 18%, Ijaw 10%, Kanuri 4%, Ibibio 3.5%, Tiv 2.5% (fig. 16; Otitie 2015).

Fig. 16: Ethnic groups in Nigeria (adapted from Stratfor 2013).

The Vice-Chancellor, Sir, it can be concluded that naturalistic explanations have failed to explain the origin of modern man, and supernatural creation is a superior model for under-standing Man's origin. The races of man likely originated from selective breeding and not a supernatural act, although they may have been the indirect result of the scattering at the Tower of Babel. In the words of Albert Robert Einstein (1809-1882), "Science without religion is lame; religion without science is blind."

The Environment

The Holy Books tell us that there are three main resources available before Creation. These are Air, Land and Water. Added to these resources are God's creatures - plants, animals, birds, fish, macroorganisms (helminths, protozoans, insects etc), microorganisms (bacteria, fungi, viruses, prions etc.) and lastly, Man. All these along with the resources form the Environment. The very delicate and dynamic interplay and interactions between the above, cause phenomenal

changes which affect the survival or otherwise of the "add-ons". The term environment describes all the physical, biological, social and cultural factors and conditions which influence the growth and well-being of an organism (Fadina and Taiwo 2001). Man, through his economic and social activities, has changed the nature of the world environment consciously or unconsciously and each of his activities has one effect or another on the health and wellness of all living creatures including human beings, their domestic animals, zoo animals, wildlife, laboratory animals and even fishes. Others are smaller organisms like insects, helminths, protozoa, bacteria and viruses, which sometimes prefer to live on or within the first group of creatures, either in symbiotic or parasitic forms, and often jeopardize their very existence by improper relationships.

Air, when fresh, unadulterated and unpolluted, just like blood, is a life giver and keeper. Air pollution is not only expressed as the pouring into the atmosphere of poisonous and obnoxious industrial, automobile and sundry gases, it is also reflected as the depletion of the popular ozone layer and the attendant exposure of the environment to dangerous rays from the sun.

Land is a natural resource on which terrestrial animals and man, amphibious and even some aquatic plants and animals depend absolutely or partly for life. Man in his quest for living and getting rid of his wastes, has turned this all-important natural resource into his ultimate killer.

Water is essential for all living organisms: aerial, terrestrial and aquatic. Water bodies serve as the ultimate sink for all substances, natural or otherwise, from both air and land. These wastes at high concentration adversely affect the physico-chemical properties of water, which consequently affect not only the biota in such water bodies, but man and animals that turn round to drink such polluted water, mostly as partly-treated or untreated, especially in the rural, semi-rural and some urban environments in developing and under-developed nations.

My Contributions to Scholarship

The Vice-Chancellor, Sir, the next question is, how did I get involved in this unpredictable triangular conundrum? At one point or the other, these three (macrophages, man and the environment) have had profound and lasting effects on my life's history over the past 25 years within this University and across Africa, notably Kenya. It was around 5pm on that fateful Thursday, 18 December, 1986, a week to Christmas, when I received a message to see my then Head of Department and mentor, Professor B.O. Ikede. Initially, I had trepidation that my Christmas season may witness another lull. Another "job" for me to do, "*when you're free*". By the time I got to his office, I found him smiling, as usual, but this time, there was something I could not pick, and hoping for the best, I greeted him. He beckoned me to sit, seeing that I was getting fidgety. Looking straight into my eyes, he asked "would you like to do your Master's project at ILRAD, Nairobi?... it will be a good experience" not waiting for me to give an answer. Then, I knew he had already made his decision, and my answer may not have had any impact. I muttered YES, with a bow. And that was it. Between February and July, 1987, I was at ILRAD (International Laboratory for Research on Animal Diseases), now ILRI (International Livestock Research Institute), a member of Consultative Group on Integrated Agricultural Research (CGIAR) of which our IITA is also a member. Being a Member of the Governing Board of ILRAD at that time, Professor Ikede had proposed that ILRAD management should engage in the training of up-and-coming African scientists from within Africa and not Africans in Europe or the Americas, who do not return to Africa to help develop their countries. Professor Ikede had recommended me for a Research Fellowship position to carry out my M.Vet.Sci. research work at ILRAD, on a platter of GOLD.

To cut a long story short, I spent 6 months researching on the "Role of Chancre in the Protective Immunity to Trypanosome infection in Goats", which was supervised by Professor Ikede and Dr. Vinand Nantulya, a renowned

Ugandan Immunologist and then Principal Research Scientist and Head of Lab. 4 at ILRAD. Our results showed that the chancre is vital for the induction of comprehensive immune recognition of the metacyclic variable antigens repertoire deposited in the skin by infected tsetse, hence development of protective immunity (Taiwo, Nantulya, Moloo and Ikede 1990). This was my first publication in an international journal of repute, Journal of Immunology and Immunopathology.

I returned to Nigeria to complete my Master's programme in July, 1987. During the six months period, I was placed on a monthly stipend of $1,200 (including free accommodation and insurance cover), which was almost two times more than what my mentor was earning then as a Professor at the University of Ibadan. What a man! an *Isoko* from the Delta coast of Nigeria.

As if that was not enough, by August, 1988 I was on my way back to Nairobi for an extension of my Research Fellowship position, on an enhanced salary, for my Ph.D. research. The title of my research was "Role of the Macrophage in the Pathogenesis of Anaemia during Trypanosome Infection in N'Dama and Boran Cattle". Vice-Chancellor, Sir, that was the beginning of my relationship with the cell called macrophage. Shortly after I started my research, Professor Ikede left Nigeria for greener pasture at University of Prince Edward Island, Canada. My second mentor and supervisor of my DVM project in 1982, Professor V.O. Anosa took over as my University supervisor, assisted by Dr. Linda Logan-Henfrey, an American Veterinary Pathologist, and Dr. Diana Williams, a British Biologist and Head, Lab. 7 at ILRAD.

For almost four years (October, 1988 to April, 1992), I was dining, wining, sleeping and waking up with these groups of cells called Macrophage. Our duty was to unravel the various roles played by this all important cell in the course of anaemia during *Trypanosoma congolense* and *T. vivax* infections in N'Dama and Boran cattle (fig. 17).

The predecessors of the N'Dama cattle we used were transferred as embryos (Jordt et al. 1986) from their Fouta Djallon Hills origin in West Africa to ILRAD, Nairobi, Kenya. The N'Dama cattle (*Bos taurus*) are known to be trypanotolerant, an inheritable trait that is constitutive but not absolute (Murray and Gray 1984); but may be affected by stress factors like poor nutrition, management, pregnancy and concurrent diseases. On the other hand, the Boran cattle (*Bos indicus*), an East African Zebu, are typically trypano-susceptible (Murray et al. 1982).

Fig. 17: Left: Two N'Dama *(Bos Taurus) cows grazing in a paddock on ILRAD site, Kabete, Nairobi. Right: A* herd of Boran *(Bos indicus)* cattle at the Kapiti Plains Ranch, near Nairobi, Kenya.

During my *encounters* with the macrophage, I harvested them from the blood, as peripheral blood monocytes (PBM), the spleen and the bone marrow of trypanosome-infected and uninfected cattle, and at a stage, buffalo. The macrophages were cultured for varying periods ranging from hours to days depending on the study, as monocultures (fig. 18), in various culture media containing mixed leucocyte culture supernatants, trypanosome lysates, lipopolysaccharide (LPS), crude and recombinant cytokines - human interferon-gamma (rIFN-γ) and bovine tumour necrosis factor-alpha (rTNF-α) at varying concentrations. They were then exposed to ^{51}chromium (^{51}Cr)-labelled red blood cells (RBC) from infected and uninfected cattle or RBC that have been pre-treated with bromelain (which alters the cell membrane sialic acid configuration and concentration). Quantitative and

qualitative analyses of sialoglycoproteins on the RBC of N'Dama and Boran cattle, and the African Buffalo were also carried out.

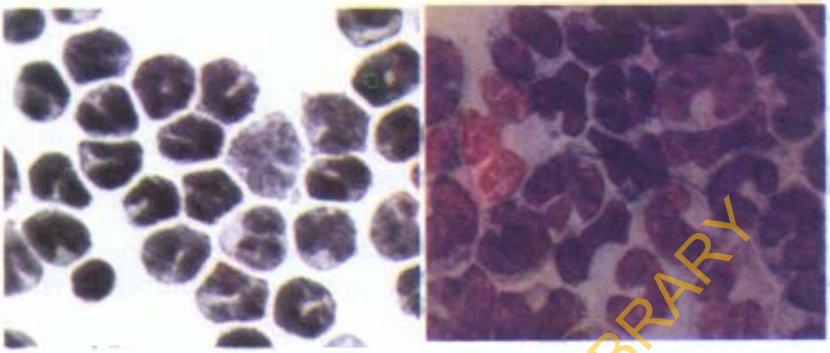

Fig. 18: Monocultures of (left) peripheral blood monocytes and (right) macrophages from the bone marrow of an N'Dama cow.

The Vice-Chancellor, Sir, the protocols are too many to give details, but most of the processes could take as long as 18 hours at a stretch. Blood sample collection from animals normally started at 6am; separation of whole non-clotted blood to plasma and monocultures of all the cellular constituents (red blood cells, neutrophils, lymphocytes, monocytes, eosinophils and basophils, when observed) on various days post-infection. Splenic and bone marrow macrophages were also routinely harvested and separated from sacrificed or dead trypanosome-infected and uninfected animals. Exposure of macrophages to labelled RBC for 4 and 18 hours, and measuring the amount of radioactivity in culture supernatants and in the harvested cultured macrophages gave the indication of both phagocytosed and digested (lysed) RBC per culture time in the various experimental conditions and animals. Biochemical assays of cell cultures, immune-labelling and differential cell counting using the fluorescein-activated cell sorter machine, SDS-PAGE analyses of secreted or elaborated proteins, sialoglycoproteins, using different techniques were carried out to identify RBC phagocytosis-inducing markers followed at the required stages of various experimental protocols. Below are some of the highlights of our published results.

1. Comparative *in vitro* destruction of RBC by macrophages (*Taiwo and Anosa 2000*)

In vitro erythrocyte phagocytosis and lysis by splenic, bone marrow and PBM-derived macrophages of Boran cattle infected with *T. congolense* increased from 14 days post-infection onwards and thereafter maintained at various levels above pre-infection (fig. 19). Cultured splenic macrophages showed the greatest RBC destruction capability, while PBM-derived macrophages had the least. The rates of *in vitro RBC* destruction were higher with the cultured PBM of the Boran than those of the N'Dama cattle during *T. congolense* infection, but similar in both groups of cattle during *T. vivax* infection.

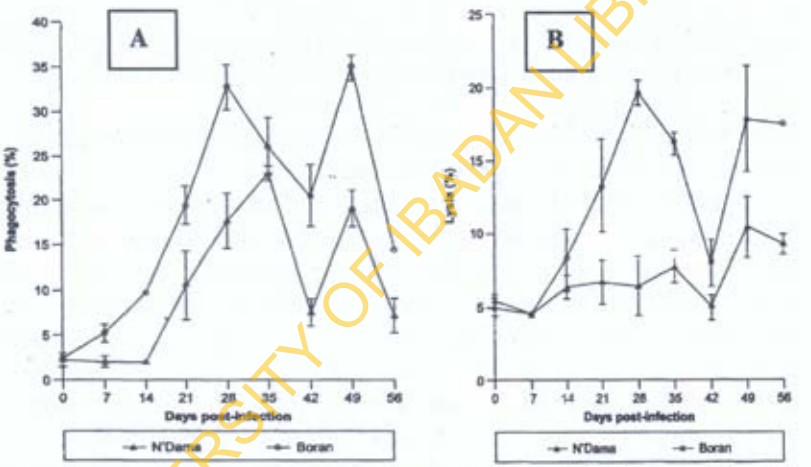

Fig. 19: In vitro phagocytosis (A) and lysis (B) of red blood cells by cultured PBM in T. congolense-infected Boran and N'Dama cattle.

There was positive correlation of the dynamics and degree of normocytic normochromic anaemia developed by these groups of cattle during both *T. congolense and T. vivax* infections. None of the N'Dama cattle needed treatment. Macrophages of both breeds, at different times post-infection or stimulation, were found to have phagocytosed one or more red blood cells (fig. 20).

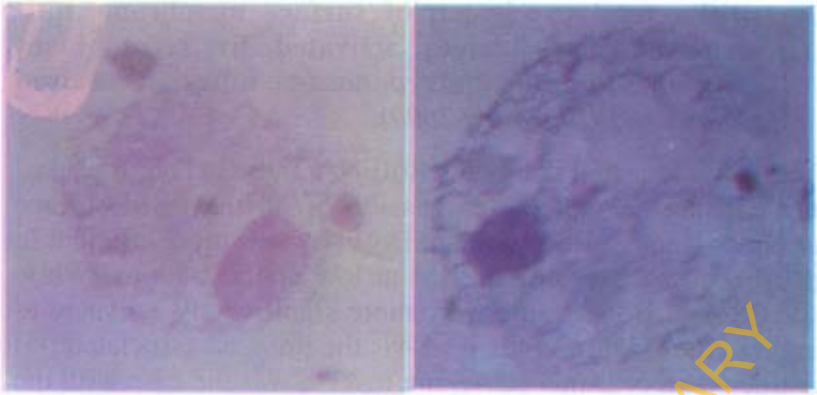

Fig. 20: Cultured macrophages from a Boran cow at 14 days post-T. congolense infection after 4 hours (left) and 18 hours (right) with phagocytosed red blood cells.

In vivo macrophage stimulatory factors, crude and acid-dialysed mixed leucocyte culture supernatants, LPS, rTNF-α. Also macrophages harvested from the bone marrow of *T. congolense*-infected Boran cattle were found to have phagocytosed numerous red blood cells and lymphocytes (fig. 21) in both breeds. These were, however, more pronounced in the Boran cattle.

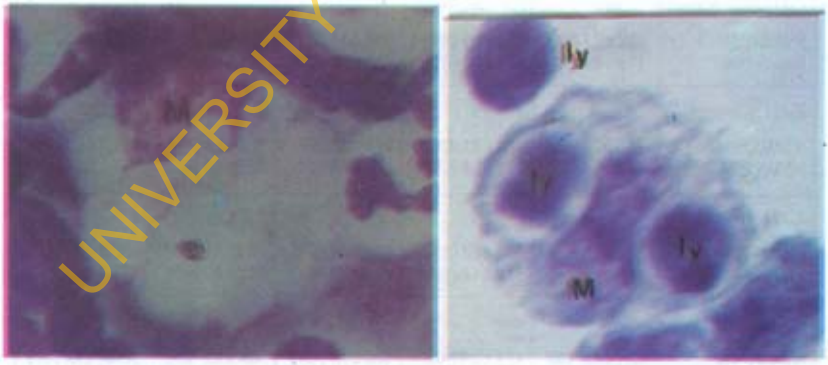

Fig. 21: Macrophages harvested from the bone marrow of a Boran cow with numerous phagocytosed red blood cells (left) and lymphocytes (right).

2. Differential expression of surface membrane antigens by macrophages activated by recombinant cytokines and during trypanosome infections (*Taiwo, Anosa and Oluwaniyi 2000*)

The study revealed that both rBoIFN-γ and rHuTNF-α caused the enhancement of the expression of all the PBM surface antigens studied. Recombinant BoIFN-γ was more efficient in causing the activation of PBM at low concentrations. While the PBM of Boran cattle were more significantly activated to express the *C3bi* receptor vis-à-vis the immune associated (Ia) antigen than N'Dama cattle, the reverse was the case with the PBM of N'Dama cattle which expressed more Ia antigens than Boran PBM. Similar results were observed during *T. congolense* infection in the two breeds of cattle (table 2 and fig. 22). Similar but non-dramatic changes were recorded for *T. vivax* infections.

Table 2: Surface Membrane Antigen Expression by PBM isolated from T. congolense Infected Cattle

MoAb (cattle breed)	Days post-infection				
	0	14	28	42	56
IL-A15 (C3bi receptor)					
N'DAMA PBM	43,2 ± 2,1 (522)[a]	52,4 ± 2,6 (608)	59,3 ± 3,4 (653)	57,8 ± 2,2 (721)	62,1 ± 1,1 (622)
BORAN PBM	41,6 ± 3,4 (601)	63,6 ± 1,2 (722)	72,4 ± 2,8 (802)	78,1 ± 1,9 (904)	82,3 ± 3,9 (832)
IL-A21 (Ia antigen)					
N'DAMA PBM	48,5 ± 1,5 (438)	92,1 ± 4,1 (625)	89,8 ± 3,8 (806)	97,2 ± 2,6 (798)	89,8 ± 2,5 (932)
BORAN PBM	43,2 ± 5,1 (471)	65,5 ± 3,8 (502)	72,4 ± 1,8 (622)	80,8 ± 4,8 (603)	81,2 ± 3,1 (728)
IL-A24					
N'DAMA PBM	39,1 ± 1,4 (159)	50,3 ± 2,1 (225)	68,1 ± 2,2 (328)	71,1 ± 2,8 (355)	68,0 ± 3,8 (421)
BORAN PBM	41,8 ± 2,2 (161)	63,2 ± 1,8 (380)	69,3 ± 3,8 (422)	79,3 ± 4,2 (438)	72,5 ± 2,7 (528)
IL-A109					
N'DAMA PBM	32,8 ± 2,6 (90)	42,4 ± 2,1 (108)	52,2 ± 1,5 (121)	38,2 ± 2,6 (68)	43,9 ± 3,2 (124)
BORAN PBM	37,2 ± 1,8 (75)	43,1 ± 1,7 (88)	48,1 ± 2,2 (130)	40,1 ± 3,2 (80)	45,8 ± 2,9 (132)

[a] Mean ± standard error (mean fluorescence per PBM); $n = 5$
IL-A24 & IL-A109 recognize monocyte/Mφ surface differentiation antigens

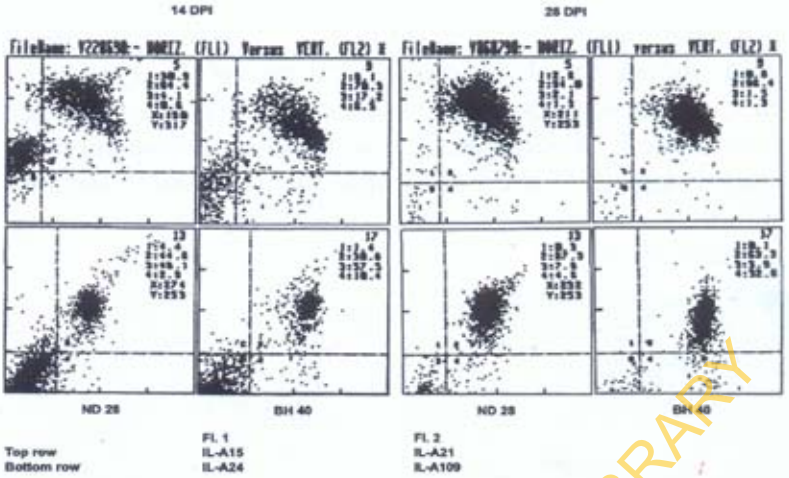

Fig. 22: Fluoresciene-activated cell sorting profile of surface antigens expression on PBM of T. congolense-infected Boran and N'Dama cattle.

The significantly higher expression of C3bi receptor and correspondingly lower Ia antigen expression by the PBM of Boran cattle, both during trypanosomosis and *in vitro* may be responsible for the higher rate of erythrocyte phagocytosis, hence the development of more severe anaemia by Boran cattle during trypanosomosis than N'Dama. In addition, the expression of significantly higher numbers of la antigen by N'Dama macrophages, hence are more able to process, present and initiate better trypanosome antigen-specific immune response than Boran cattle during infection. These two attributes are known genetic characteristics of trypanotolerance in cattle.

3. Non-immune control of trypanosomosis: *in vitro* oxidative burst of PMA- and trypanosome stimulated neutrophils of Boran and N'Dama Cattle (*Taiwo, Adejinmi and Oluwaniyi 2002*)

This study showed that phorbol myristate acetate (PMA) and trypanosomes caused an enhanced *in vitro* oxidative burst, hence trypanosome phagocytosis and killing activity of

neutrophils and some eosinophils (fig. 23). Neutrophils have been shown to play very significant roles in parasite clearance, hence reduction of trypanosome parasitaemia. The rates of both *in vitro* generation of O_2^- and trypanosome phagocytosis did not differ significantly between Boran and N'Dama breeds of cattle, even during *T. congolense* infection in this study.

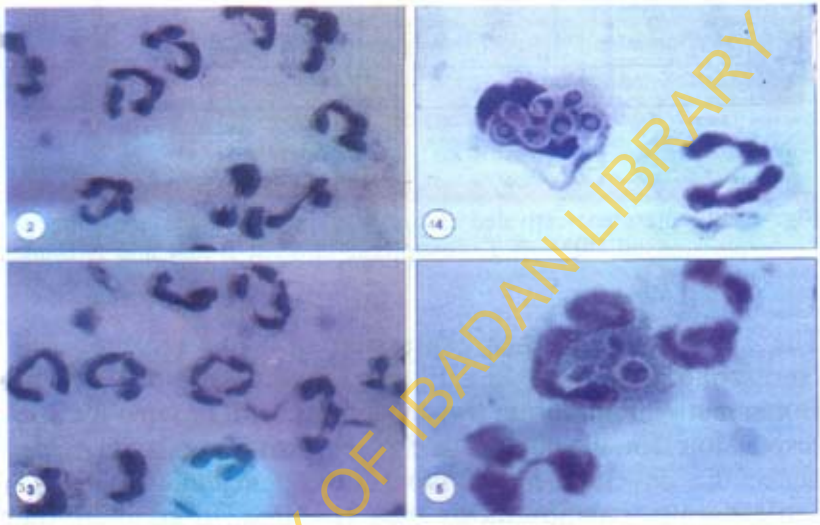

Fig. 23: Neutrophils (panels 1, 2 and 3) and an eosinophil (panel 4) in in vitro co-stimulation assays, showing trypanosome phagocytoses.

It was inferred that sustained and higher parasitaemia, more pronounced neutropenia, inadequate bone marrow response and less effective trypanosome-specific immune response, rather than defective neutrophil trypanosome destruction, may be the problem of trypanosusceptible cattle breeds.

3. Quantitative and qualitative red blood cell sialo-glycoprotein profiles in Zebu and N'Dama cattle and buffalo (*Taiwo and Ogunsanmi 2000*)

Comparative assays on the concentration and types of sialoglycoproteins (glycophorms; GP) on the red blood cell membrane of three different cattle breeds and buffalo were

carried out using 10 N'Dama, 14 White Fulani (West African Zebu; WAZ), four Boran (East African Zebu; EAZ) and two buffaloes. The red blood cells of WAZ and EAZ cattle contained significantly lower concentrations of sialoglycoproteins (9.85±0.61 and 9.46±1.35 ing/10^9 red blood cells, respectively) than those of N'Dama cattle (Ibadan-based, 12.54±0.37; Nairobi-based, 12.28±0.85 ing/10^9red blood cells) and buffalo (10.43±1.25 mg/10^9 red blood cells). Electrophoretic separation of the erythrocyte GPs revealed that N'Dama cattle, its 75% crosses and buffalo expressed three bands corresponding to human red blood cell GPA, GPC and GPB, with 39, 30 and 25 kDa apparent molecular masses, respectively (fig. 24). On the other hand, WAZ cattle expressed GPA and GPC while EAZ cattle RBC expressed only the GPA band (fig. 24).

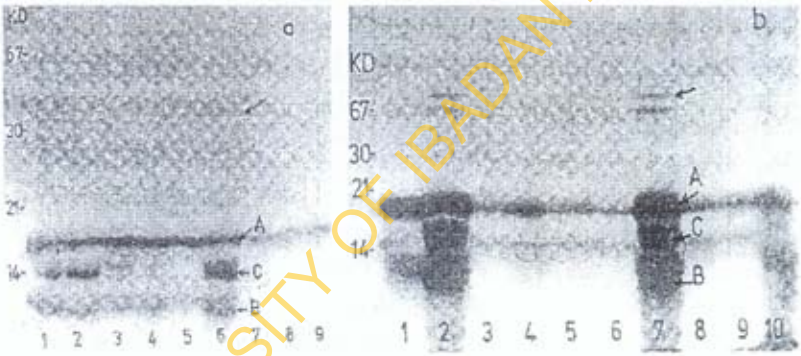

Fig. 24: Electrophoretic (SDS-PAGE) separation of bovine erythrocyte membrane glycophorins. (a) Nairobi-based N'Dama (lanes 1, 2, 3 and 4), buffalo cow and bull (lanes 5 and 6, respectively) and EAZ (lanes 7, 8 and 9). (b) Ibadan-based pure N'Dama (lanes 2 and 7), 75% N'Dama x 25% WAZ crosses (lanes 1 and 10) and WAZ (lanes 3, 4, 5, 6, 8 and 9).

These findings indicate that the N'Dama cattle and buffalo, both of which are known to be trypanotolerant, have qualitatively and quantitatively higher levels and types of sialoglycoproteins on their red blood cell membranes. The crosses of both WAZ and N'Dama also expressed quantitative and qualitative sialo-glycoprotein profiles of the

N'Dama, showing that it is a heritable trait that may enhance or serve as a marker for trypanotolerance.

My Home Coming

The Vice-Chancellor, Sir, at this juncture, I rounded off my Ph.D research work, and started to write up the thesis, when I was informed by my colleagues back in Nigeria that some vacancies had been advertised for our Department for the position of Lecturer II, and that if I was interested, I should put in my application. This, I promptly did, since it was the policy of ILRAD that African Research Fellows must return to their countries on the completion of their researches. To cut a rather interesting and long story short, I was interviewed *in absentia* and offered the appointment. I returned to Ibadan on 05 July, 1992 and assumed duty in the Department on 02 September, 1992.

You will recall, Vice-Chancellor, Sir that my return to the country was during the preparations for the 29 May, 1993 Elections tagged "HOPE 93", which became a "hopeless venture", no thanks to the June 12, 1993 Election Annulment by the General Ibrahim Badamosi Babangida (rtd.)-led Military Junta and the subsequent transition of the whole nation of Nigeria into a "pariah state". Vice-Chancellor, Sir, we are all witnesses to the ominously dark clouds that overshadowed the whole country from 1993 to 1999. The sufferings at individual and national levels were unprecedented in our national history. This was a time where and when nothing worked. The numerous Workers Unions' Strike Actions, including our own Academic Staff Union of Universities (ASUU), the nationwide and international protests led by NADECO and other interested pressure groups, public protests, burn-fires and total breakdown of national security, and almost all social amenities including NEPA is all history today. Remember the popular ASUU slogan - "My Take Home Pay, Cannot Take Me Home". There was total anarchy, disorderliness, hunger and anger nationwide.

I came into the country when all these were going on with bright hopes of continuing my dream studies on the "macrophage", with which I seemed to have had a pact to

unravel its secrets of managing the affairs of God's creatures, maintenance of homeostasis, prevention and ameliorating the various sicknesses and diseases that may afflict them "as ordained by God", at least that was, and still is, the way I perceived it.

I came back with numerous panels of monoclonal antibodies, clones of different species of trypanosomes, recombinant cytokines and growth factors, among several light equipment that were to enhance my continuing researches, having been trained and adept in many aspects of world-class biotechnological procedures, including computer-driven Information Technology. I was indeed very lucky to have had such training experience.

Lo and behold, the situation in Nigeria at that time gradually saw me lose all the reagents that I had brought from Nairobi to incessant and prolonged power outages, insecurity and extreme poverty. I wrote four manuscripts from my Ph.D thesis shortly after my defence on 19 January, 1993, but was unable to get them published until early 2000. This was because it was difficult to have a journal of any repute outside Nigeria to accept any research manuscript from Nigeria; Even if they would, our National Postal System at that time made matters worse; they dumped all mails at the Airports, unsent. Not many journals have IT-driven manuscript handling system at that time. We are all witnesses.

My personal and family lives took a deep plunge into abysmal darkness, unprecedented in my existence. Life was very hard for me and my family. We lived through a stage where the military might at that time wanted to eject us (Lecturers) from our residences on Campus. The first culprit was my family; ***I became a single parent, and had to single-handedly fend for five children, four "big" boys and an infant girl, along with a retinue of cousins, nephews and nieces, the parents of who had in one way or the other, assisted me in my life's journey to get to where I was***. I toyed with the idea of leaving the country for Kenya or South Africa, where I was sure of a good job and better life. But the idea of leaving behind my young children to their fate in

Nigeria was very repugnant to me. I decided that I would rather stay and struggle it out in Nigeria. Apart from hunger, insecurity and very hostile environment, I was ingloriously "engulfed" by the then environmental macrophage and sent into the deep "belly" of the "BIBLICAL JONAH-WHALE".

Fig. 25:
phillipmartin.info

Jonah is the central character in the Book of Jonah. Commanded by God to go to the city of Nineveh to prophesy against it:

> "for their great wickedness is come up before me,"[2] Jonah instead seeks to flee from "the presence of the Lord" by going to Jaffa and sailing to Tarshish, which, geographically, is in the opposite direction. A huge storm arises and the sailors, realizing that it is no ordinary storm, cast lots and discover that Jonah is to blame. Jonah admits this and states that if he is thrown overboard, the storm will cease. The sailors try to dump as much cargo as possible before giving up, but feel forced to throw him overboard, at which point the sea calms. The sailors then offer sacrifices to God. Jonah is miraculously saved by being swallowed by a large fish in which he spends three days and three nights.[3] While in the

> great fish, Jonah prays to God in his affliction and commits to thanksgiving and to paying what he has vowed. God commands the fish to spew Jonah out (Jonah, Chapters 1 and 2).

This story about Jonah is also iterated in *Qur'an, chapter 37 (As-Saaffat), verses 139–144.*

When God saw the HEART of Jonah, He forgave him, but re-ordered him to go back on the initial errand:

> "Arise, go to Nineveh, that great city, and preach to it what I command you." So Jonah went to the city of Nineveh; and as he entered into it, he called out to the people (Jonah 3:2).

We all knew what happened thereafter.

The Vice-Chancellor, Sir, I am not sure I heard any command from God, which I refused to heed, nor did I have any spiritual message from any prophet and refused to atone. I wasn't any strong Christian at that time, but I was attending church and listening to very excellent sermons by my *spiritual oversights* at SPCC. What I went through at that time was an anti-climax of my life. The details would form the bulk of my autobiography, if I eventually decide to write one. The summary of these are that I was ingloriously incarcerated in police custody at the State Criminal Investigation Department, Iyaganku, Ibadan for 13 days, and a 6 months-long court process leading to my discharge and acquittal, for an offence I knew nothing about. Thanks be to God Almighty for my wife, then my girlfriend, my in-laws, relatives, ASUU, my Union and friends whose identities would be revealed adequately in my Acknowledgements.

The Vice-Chancellor, Sir, that period was the darkest so far in my life history. Initially, upon being put into the cell, I cried like I was going to die, for the first two days; then I resigned to fate and started asking God what I had done to warrant these undeserved punishments. During my sleep on the third night, the police arrested one of the burglars who

exonerated me (at a "proper identification parade"), God spoke to me, and said "... it is in your very best interest to be in here, than to be outside there to be consumed ..." Then it dawned on me that I was in a "Spiritual confinement". Since that moment, I kept on praying, singing and giving thanks to God, asking for forgiveness of my sins and the humility to forgive all that have wronged me, even those who overtly or covertly made me to be so engulfed by the "Environmental Macrophage in Jonah's Whale". I voluntarily became the "church leader and prayer warrior" in the cell. I admonished my fellow inmates to among others, forgive themselves and those who may have led them into being there in the cell, in their own "glorified self interest" as preached on many times by my Spiritual Oversights, Pastor and Mrs. Olubi and Sarah Johnson.

I now believe that God "saw" my Heart and forgave and preserved me. I even enjoyed divine help from a young police officer at the station, who staked his life to prevent me from being taken away for "interrogation" by another police "detective" on the night of my arrest. I shall eternally be grateful to God who, through this police officer, preserved me from the brutality and extreme humiliation I could have gone through. To this day, I have never had any cause to be despondent and lose hope and self-esteem. I returned to the university campus with my head raised high, though battered, like the proud moulting cock (fig. 26), I strode tall and went about my academic and research work as usual.

Fig. 26: ... life continues, despite the torn clothes ...

Vice-Chancellor, Sir, I affirm that I bore and still bears no grudge against anyone directly or indirectly connected with the incident, because the event had helped to re-shape my life and outlook, especially to be very aware of my environment, *spiritual, physical, social*, and in research which is the theme of my next life's story.

Man and His Environment

The Vice-Chancellor, as I had said earlier, at creation, the earth's major resources are *Air, Land* and *Water*. Added to these are plants, animals, insects, birds, fish and man, all which form our *Environment*. The very delicate but dynamic interplay and balance between the components in the environment affect their survival. Man, through his activities, has changed the nature of the world environment consciously or unconsciously and this has had one effect or another on food security and safety. Fresh, unadulterated and unpolluted air, just like blood, is a life giver and keeper. Air pollution is not only expressed as the pouring into the atmosphere of poisonous and obnoxious industrial, automobile and sundry gases (fig. 27), it is also reflected as the depletion of the popular ozone layer and the attendant exposure of the environment to dangerous rays from the sun.

Land is a natural resource on which terrestrial animals and man, amphibious and even some aquatic plants and animals depend absolutely or partly for life. Man in his quest for living and getting rid of his wastes, has turned this all-important natural resource into his ultimate killer (fig. 28).

Fig. 27: Automobile (left) and industrial gas emissions into the atmosphere.

Fig. 28: Typical (former) waste dump sites at a popular abattoir in Ibadan, where animals and man "compete for living".

Water is essential for all living organisms—aerial, terrestrial and aquatic. Water bodies serve as the ultimate sink for all the substances (fig. 29), natural or otherwise, from both air and land. These wastes at high concentration adversely affect the physico-chemical properties of water, which consequently affect not only the biota in such water

bodies, but man and animals that turn round to drink such polluted water, mostly as partly-treated or untreated, especially in the rural, semi-rural and some urban environ-ments in developing and under-developed nations.

Fig. 29: Industrial effluent (left) and crude oil spill (right) into water bodies.

Food Safety and Security

Mr. Vice-Chancellor, Sir, in August, 2001, I attended an International Conference on Food Safety and Security with the theme "Enhancing Food Safety and Security in Nigeria" at the International Institute for Tropical Agriculture (IITA) sponsored by USDA/USAID/Federal Government of Nigeria. Professor Ango Abdullahi, the then Special Adviser to the President on Food Security, in his opening address said;

> ... It is common knowledge that apart from the physical quality prescriptions required for (export-bound agricultural) commodities and food products, there is a very high premium placed on the physiological, chemical and microbial concerns of these products which together constitute and determine their safety characteristics for human consumption ...
>
> ... It is generally agreed that these institutions and their facilities are still at their rudimentary stages of development, and a great deal still needs to be

> done to bring them to the efficient and effective standards often found in developed agricultural economies in the other parts of the world ...

These statements, among others, were the catalysts that spurred me to engage some of our colleagues in the Departments of Veterinary Public Health and Preventive Medicine, Crop Protection and Environmental Biology, Animal Science, the then Wildlife and Fisheries Management, Chemistry, Physiology and Human Nutrition to work together on issues relating to food security and safety in man and animals. The experience is awesome and highly rewarding. Vice-Chancellor, Sir, Food Security is defined as

> access by all people at all times to the food required for them to lead a healthy and productive life (Webb and von Braun 1994)

Its extreme opposite, Food Insecurity or Famine is

> a catastrophic disruption of society as manifested in a cumulative failure of food production, distribution and consumption systems (Webb and von Braun 1994)

In public health parlance, Food Safety is the

> presentation to man and animals of food, which is wholesome, balanced and health giving

Worldwide food shortages and skyrocketing prices of food and feed items for man and animals at that period, and till now, in our national history made many farmers and animal feed producers to start looking for alternative sources of feed ingredients to replace or substitute the expensive and highly economically competitive conventional grains such as maize, sorghum, beans and millet, as well as other sources of animal and plant oils to augment human and animal food and feed resources. These efforts are often fraught with challenges of processing and detoxification. In our efforts to play our roles

in food security and also to ensure safety of foods/feeds for man and animal, we carried out animal model experimentations on the evaluation of these non-conventional sources for effectiveness of replacements with little or no toxic side effects on the animals and by extension, man. We also carried out toxicological and therapeutic effects of some known and obscure plants as herbal preparations for the treatment of common diseases and ailments, especially in man.

The following sets of experiments, which I consider as positive efforts in "harnessing our untapped resources and improving our environmental attributes", were carried out.

(i) Sole feeding of poultry faeces to *Clarias gariepinus* accompanied by toxicity, as shown by widespread hepatocellular degeneration and necrosis, renal congestion and tubular necrosis, and weight loss (Agbede, Ogunsanmi, Taiwo, Oso and Ogundipe 1999). This implied that poultry faeces should not be recommended as a 100% substitute for conventional ingredient in fish rations in commercial fish farming.

(ii) Replacement of maize with offal in diets of grower pigs did not affect the growth, serum total proteins, creatinine and urea values, apparent digestibilites of the ether extract, and serum cholesterol levels. We (Adeshehinwa, Ogunsanmi, Nssien and Taiwo 1999) concluded that maize offal could be safely and economically utilized in the diets of grower pigs.

(iii) Oyelese, Taiwo, Ogunsanmi and Faturoti (1999) demonstrated, in toxicological assays where processed and differently processed cassava peels were used to replace maize in fish diets, that though it is practically impossible to completely detoxify cassava peels, *C. gariepinus* fingerlings can survive hydrocyanic acid levels in feed up to 180ppm and 60% maize replacement level when the peels were first steam-autoclaved and then oven-dried. This we

observed will drastically reduce maize requirements in fish diets and improve profit margins.

(iv) Olukunle, Ogunsanmi, Taiwo and Samuel (2002) reported that for optimal growth performance, best nutrient utilization and unimpaired haematological and plasma enzyme activities in hybrid *Clarias*, a 5% inclusion level of sun-dried cow blood meal can be used as protein supplementation in the feed, thus reducing production costs and improving yield.

(v) In separate experiments, Iyayi and Taiwo (2003), Iyayi, Taiwo and Fagbohun (2005) and Iyayi, Ososanya, Taiwo and Adeniji (2006) provided ample evidence that heat-processed Mucuna (*Mucuna utilis*) and velvet beans (*Mucuna pruriens*) can be used as replacements for soybean meal in the diets of starter and finisher broilers and laying hens, thus considerably relieving soybean for human use and reduce production costs. Inclusion levels of above 6% caused reduction in the birds' performance because of the level of anti-nutritional factors in Mucuna.

(vi) Akinnawo, Taiwo, Ketiku and Ogunbiyi (2005) recorded positive growth changes and minimal organ pathology in rats given edible larvae of *Cirina forda* (Westwood), known as *monimoni* or *ekuku* in Yorubaland. We recommended its consumption to augment protein availability and prevent protein malnutrition in humans, and possibly as a protein supplement in animal diets.

(vii) Olukunle, Taiwo and Adejinmi (2000) carried out a comparative assessment of growth performance of hybrid catfish fed non-conventional plant proteins in homestead concrete tanks and found out that these plant protein sources can be conveniently effectively used.

(viii) Olaifa, Ajayi, Taiwo and Bello (2012) reported that the supplementation of the feed of *C. gariepinus* with the African oil bean (*Pentachlethra macrophylla* Benth) seed residues caused an enhancement of feed utilization and growth in the fish.

(ix) Series of experiments were carried out on toxicological evaluation and dietary effects on growth of rats fed oils extracted from non-conventional oilseed sources such as *Telfaria occidentalis* (Ajayi, Oderinde, Taiwo and Agbedana 2004), *Garcinia mangostana* (Ajayi, Oderinde, Ogunkoya, Egunyomi and Taiwo 2007), *Terminalia catappa, Pentaclethra macrophylla* and *Calophyllum inophyllum* (Ajayi, Oderinde, Taiwo and Agbedana 2008), and *Monodora myristica* (Ajayi, Ajibade and Taiwo 2013). Our results showed that oils from *T. catappa, G. mangostana* and *M. myrisitica* are suitable for both human consumption and as industrial oils. The oils from *C. inophyllum, P. macrophylla* and *T. occidentalis* are suitable only for industrial use because of toxicities in rats associated with their consumption, even at 5% standard inclusion levels. This was due to the presence of high levels of unsaturated fatty acids such as linoleic acid and oleic acid (*C. inophyllum, P. macrophylla*) and erucic acid (*T. occidentalis)* in these oils. For example, ingestion of *C. inophyllum* and *P. mangostana* seed oils by rats caused severe diffuse hepatocellular degeneration and necrosis (fig. 30) and myocardiac degeneration, fibrosis and presence of artherosclerotic clefts in cardiac blood vessels (fig. 31), respectively.

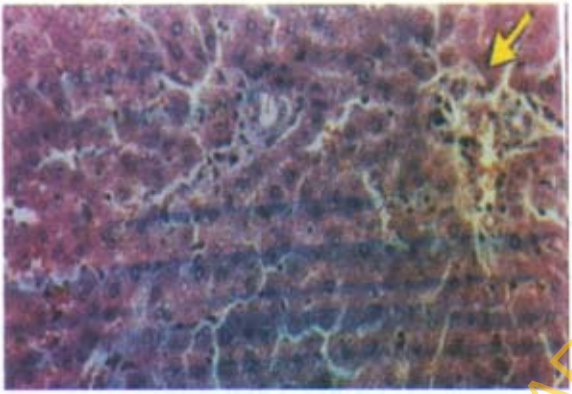

Fig. 30: Liver of rat given 5% *C. inophyllum* oil in normal rat feed showing diffuse vacuolar degeneration of hepatocytes, periportal hepatic necrosis and inflammatory cellular infiltration (arrow). H&E x450.

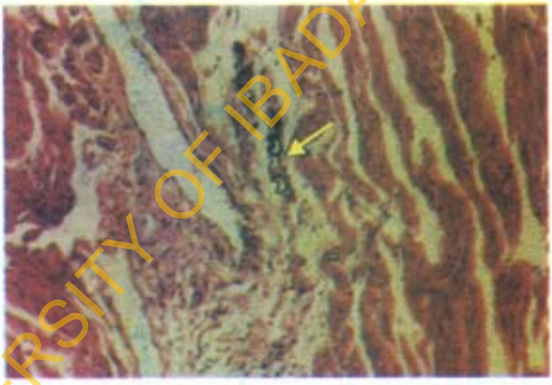

Fig. 31: Heart of rat given 5% *P. macrophylla* oil in normal rat feed showing myocardiac degeneration, fibrosis and presence of artherosclerotic clefts in a vasa vasorum (arrow) H&E; x 450.

Also the seed oil of *T. occidentalis* caused artherosclerotic changes in the walls of vasa vasori and lymphatics in the heart (fig. 32), as well as degenerative changes in the myocardium and liver of the rats. The oil from the seed of *M. myristica* was found to be a promising edible vegetable oil.

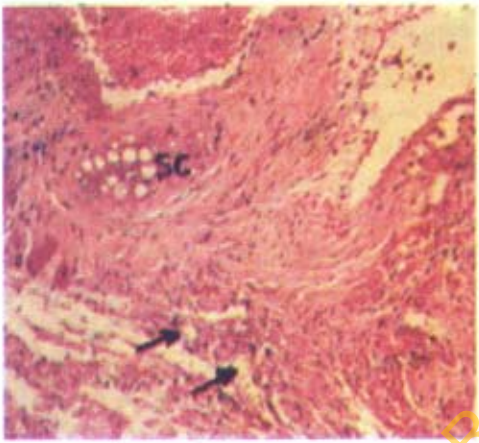

Fig. 32: Heart of rat given 5% *T. occidentalis* oil showing hyaline degeneration and necrosis of the myocardium. Note thickened sclerotic and calcified wall of a vasa vasorum (SC) and lymphatics (arrows) with cholesterol clefts attached to the endothelium (H&E; ×450).

(x) Aloe vera (L), a member of the family *Liliaeceae*, is a popular perennial succulent plant that is cactus-like in its characteristics (Tyler 1993). The plant has a long history as a multipurpose folk remedy (Reynolds and Dweck 1999), and has been associated with myths, magic and medicine since pre-biblical times (Balter 1992). It is acclaimed to cure ailments ranging from mild fever, wounds and burns, gastrointestinal disorders, diabetes, sexual problems, among many other claims. Here in Nigeria, there is a very strong cultural belief in herbal medicare, most often due to the latter's economic advantage and easier reach compared to the high cost of orthodox medicine. This is com-pounded by low literacy rates and often epileptic and grossly inefficient orthodox healthcare delivery system.

Since the sudden introduction and widely acclaimed mega-therapeutic potentials of *A. vera* and its products (the *cure-all* craze) in the mid 1990s, and the highly expensive "processed" *A. vera* products, it is common to see homestead *A. vera* "plantations" at every corner in most towns

and villages (fig. 33). This has led to usually unrecommended and uncontrolled consumption of raw *A. vera* leaves by the low and mighty in the society. Conflicting reports on the therapeutic potentials of *A. vera* (Schmidt and Greenspoon 1993), its toxicity, especially when used parenterally (Brusick and Menge 1997; Balter 1992; Tyler 1994), and the fact that most advertised *A. vera* products have no specific approval for use by the Food and Drug Administration of the United States of America (FDA) (FLP 2003; Changes International 2004) necessitated our research on the implications of the consumption of aqueous extract of raw *Aloe vera* leaves on the organs and serum biochemistry of rats and tilapia fish.

Fig. 33: Homestead Aloe vera "plantations"; a common site in metropolitan Ibadan in the early 2000s.

Our results (Taiwo, Olukunle, Ozor and Oyejobi 2005) showed that fish cultured in water containing different concentrations of *A. vera* exhibited erratic swimming patterns, rapid opercular movements, skin depigmentation and died within 24-96 hours. Gross and histologic tissue lesions in the fish include, among others, pale and shrivelled gills, stunting of gill

filaments, necrosis of gill epithelial cells (fig. 34a), hyaline degeneration and necrosis of gill filaments, hepato-cellular vacuolar degeneration and necrosis.

Changes in test rats included moderate to severe normocytic normochromic anaemia, hypproteinaemia, increased AST levels, and decreased cholesterol and triglyceride levels. Gross and histologic tissue lesions included pulmonary congestion, intestinal villous atrophy (fig. 34b), flabbiness of the heart, hepato-megaly, degeneration (fig. 34c) and necrosis of hepatocytes, renal glomerular and tubular degenera-tion and necrosis (fig. 34d). The severity of these changes increased with increasing concentrations of *A. vera*, showing that *A. vera* is very toxic to fish and rats, and may also be similarly toxic to humans.

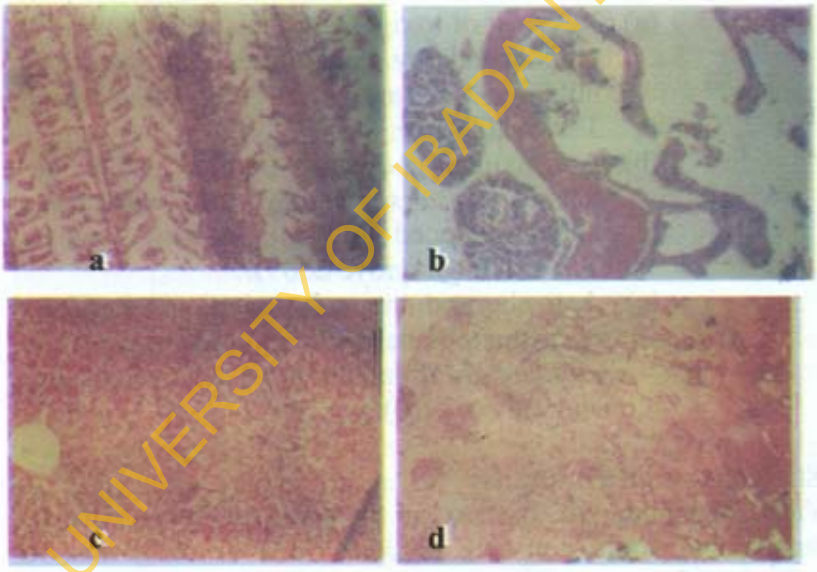

Fig. 34: (a) Gill of Tilapia in 50ppm A. vera showing widespread vacuolar degeneration and necrosis of gill epithelial cells; (b) severe intestinal villous atrophy in Tilapia in 50ppm A. vera; (c) liver of rat given 150ppm A. vera in water showing diffuse periportal and centrilobular vacuolar degeneration; and (d) kidney of rat given 50ppm A. vera in water showing severe degeneration and necrosis of glomeruli and tubules (Taiwo et al. 2005).

(xi) Also, Adeogun, Alaka, Taiwo and Fagade (2012) reported organ pathological changes in *C. gariepinus* exposed to sublethal doses of the methanolic extract of *Raphia hookeri*.

(xii) Nottidge, Omobowale, Taiwo, and Omotoso (2008) reported the histopathological changes caused by ethanolic extract of the fruits of *Garcinia kola* in dogs and warned on the implication of excessive human consumption of bitter kola.

(xiii) We carried out experiments using different extracts of plant materials for the amelioration and/or cure of common conditions or diseases in animal models, preparatory to their recommendation for use in man. These include:

(a) Reversal of toxigenic effects of aflatoxin B1 on cockerels by alcoholic extract of African nutmeg, *M. myristica* (Oluwafemi and Taiwo 2004).

(b) Anti-oxidant and anti-hyperglycemic activeties of *Musa sapientum* roots extracts in alloxan-induced diabetic rats (Adewoye, Taiwo and Olayioye 2009).

(c) Anti-plasmodium and toxicological effects of methanolic bark extract of *Chrysophyllum albidum* in albino mice (Adewoye, Salami and Taiwo 2010).

Environmental Pollutants

Vice-Chancellor, Sir, the next in the series of my studies are those one would consider as deleterious or dangerous to animal and human life, and hence termed negative issues regarding the use of our environment. They are concerned with environ-mental pollution and its attendant effects on living, health and wellness. Pollution is an undesirable change in the physical, chemical or biological characteristics of air, water and soil that may harmfully affect the life or create a

potential health hazard of any living organism and in particular for man (Flower 2006) and animals.

There are two basic types of environmental pollutants—biodegradable and non-degradable. The former include domestic sewage or municipal and industrial effluents, some of which rapidly decompose by natural processes and engineered systems. When allowed to pile up in very high concentrations in the environment, especially in inland water bodies, the issue of safety is overshadowed by the need for such waters by man and his animals, bio-accumulation in the food chain with disastrous health and productivity consequences. The non-degradable pollutants are plastic cans and bottles, polythene bags, plastic containers and wares, aluminium cans, mercurial salts, Cu, Cd, Pb, Co, Zn, long-chain phenolic chemicals, DDT etc. These types of pollutants do not degrade or degrade only very slowly in the natural environment. They do not only accumulate in the environment, they have been shown to be "biologically magnified" as they move in biogeochemical cycles along food chains (Kumar 1980) causing considerable morbidity and mortality. Rapid world population increase coupled with global and local technological advances in agricultural and industrial practices, and misuse or abuse of these practices have brought about the introduction of various substances into the aerial, terrestrial and aquatic ecosystems, leading to the alteration of the course of evolution and shift in the "balance of nature".

Environmental pollutants tend to simplify the community structure through the elimination of the more sensitive plant and animal species, cause changes in inter-species relationships within the community, and alter nutrient cycles and subsequently affect the composition of the community. The aerial, terrestrial and aquatic resources, placed at the disposal of man, are very abundant; they vary in composition and are renewable. Irresponsible usage, overuse or neglect in some cases, of this resilient but fragile ecosystem (usually by man), cause varying degrees of ecological disasters, which

adversely affect man and his livestock (including aquatic) both in terms of availability and quality of life. For instance, lack of adequate food resource for man and his animals will affect their productivity, while unwholesome and unsafe food will not only affect productivity, it will lead to morbidity and mortality.

The damages that air pollution cause to man and his livestock are very enormous. Dangerous fumes and effluents from industries, automobile and sundry sources can cause asphyxiation and death or severe irritation of the upper respiratory system, thereby initiating or complicating innocuous respiratory or other systemic diseases in man and livestock. Occurrences of "acid rains" have been reported in various parts of Nigeria within the last 10-25 years. Vice-Chancellor, Sir, on Thursday, 12 July 2001, a mortality of 75% was reported in an experimental homestead 1,000 *Clarias and Heterobranchus* breeding stock within 4-6 hours after a moderately heavy rain in an environment where coal tar had been used for sealing leaking roofs of buildings within our campus. Our findings revealed acute anoxia as a result of gill filament necrosis and denudation (fig. 35), due to CO poisoning in the aquaria.

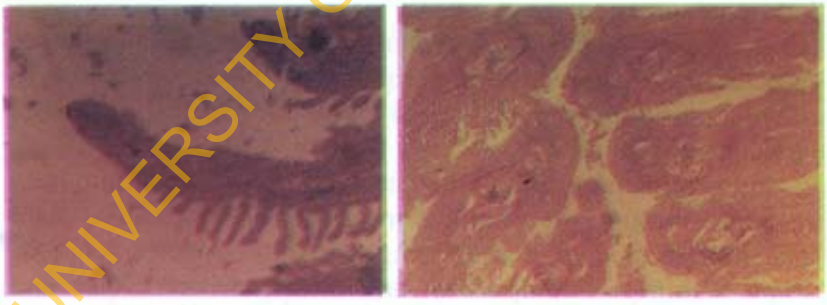

Fig. 35: Necrosis and denudation of gill filaments and villi of Clarias X Heterobranchus breedstock fish exposed to CO poisoning (Taiwo and Olukunle, unpublished finding).

Another example is the dislocation of a community in Delta State, Nigeria by "salt rain" (*Anchor Newspaper, 12 July 2001: page 3*) from aerial pollution with mist from a salt manufacturing company in the locality. Many people and livestock in the community were reported sick, and some died. Many of such incidences have been reported in the press, but many remain unknown or simply not reported.

Vice-Chancellor, Sir, when I was on sabbatical and accumulated leaves at the Department of Veterinary Pathology, University of Maiduguri. in 2005/2006 and 2006/2007 sessions, respectively, the first thing that shocked me was the presence of swarms of houseflies (fig. 36), virtually everywhere, in human and animal habitations, and notably and menacingly, in fish and meat markets. In local markets, you would virtually hand-scoop the flies before you can even see the fish or meat you want to buy. I resorted to buying my fish and meat from meat shops, where the population of these flies was being controlled by almost 24 hour use of smouldering "mosquito coils" and commercial insecticidal sprays.

I later observed that even after two washes, I could still smell the coil smoke in my meat/fish. Worried by the implication of the continuous exposure to pyrethroids (d-Allethrin, Cypermethrin and d-Tetramethrin), and the binding materials and formaldehyde, in just one coil, as reported by Liu et al. (2003), to be equivalent to burning 51 cigarettes, Myself and my postgraduate students (Taiwo, Nwagbara, Suleiman, Angbashim and Zarma 2008) designed a series of experiments wherein we exposed adult Wistar rats to graded doses of aerosolized insecticidal spray and fumes from mosquito coils for 15, 30, 45 and 60 seconds in two divided doses daily for 18 days. Our results revealed varying degrees of degenerative and necrotic lesions in the intestines, liver, heart, kidney, lung and brain due to blood vascular damage and multiple thrombosis of blood vessels (figs. 37, 38, 39 and 40).

Fig. 36: Swarms of nauseating houseflies on the wall (left) and food (a chapatti meal) of a friend in Maiduguri.

These findings revealed the implications of the consistent and uncontrolled use of pyrethroids-containing insecticides on farm and market produce and the public health implication of same. Miller (2004), reported that the environmental impact of is greater than what is intended by those who use them and that over 98% of sprayed insecticides and 95% of herbicides reach a destination other than their target species, which include non-target species, air, water, bottom sediments and food.

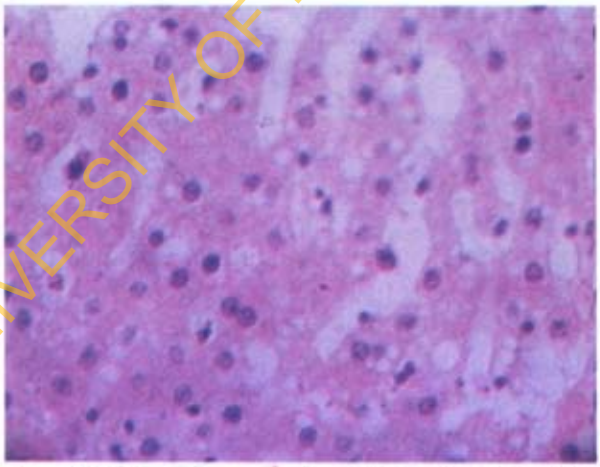

Fig. 37: Liver of albino rat exposed to 4.20mg/kg BW of dallethrin in mosquito coil fumes for 12 days showing severe widespread vacuolar degeneration and necrosis of hepatocytes (H & E; x450).

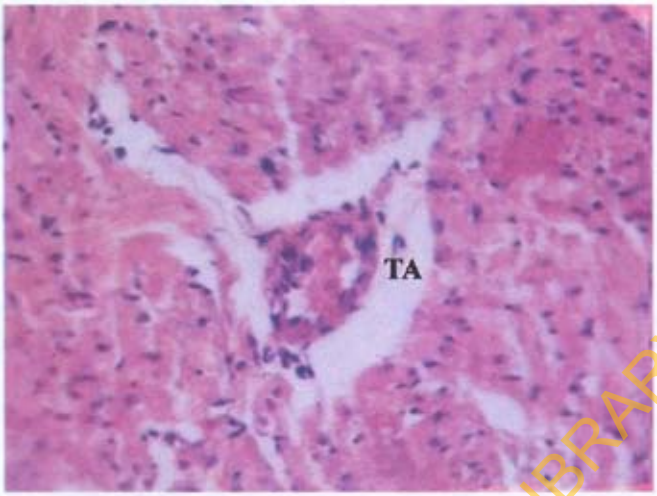

Fig. 38: The heart of albino rat exposed to 2.40mg/kg BW of pyrethroids in aerosolized insecticidal spray for 12 days showing vacuolar and hyaline degeneration of myocardiac fibres, mononuclear cell infiltra-tion, vasculitis and thrombosis of an artery (TA) (H & E; x450).

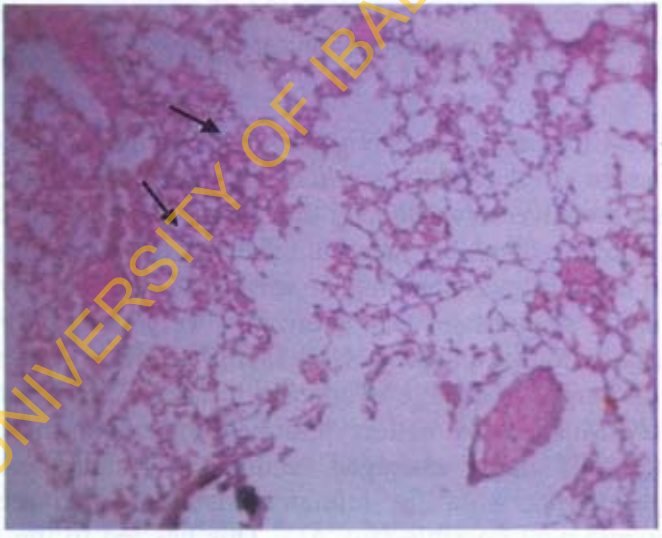

Fig. 39: Lung of albino rat exposed to 2.00mg/kg BW of pyrethroids from aerosolized insecticidal spray for 9 days showing moderate thicken-ing of interalveolar septa and multiple thrombosis of blood vessels (arrows) (H & E; x450).

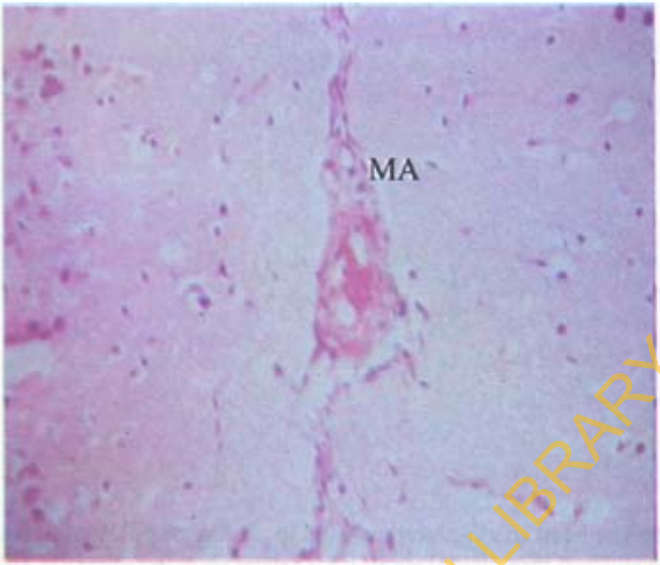

Fig. 40: Cerebrum of albino rat exposed to 2.8mg/kg of pyrethroids from aerosolized insecticidal spray for 12 days showing fibrinoid degeneration and thrombosis of a meningeal arteriole (MA), moderate neuronal degeneration, neuronophagia and mild spongiosis (H & E; x450).

Vice-Chancellor Sir, in Nigeria, the direct and indirect abuse or overuse of the land resource and inefficient agricultural policies are adversely affecting the quantity and quality of food supply to man and his animals. The negative environmental impact of improper dumping of wastes on man and livestock production systems is very enormous. Very poor harvesting, inadequate storage and processing facilities have caused serious food shortages and huge economic losses in the agricultural industry. Most of the abattoirs and meat markets in the country are not only badly managed, animals are slaughtered and transported and sold for human consumption in the most unhygienic way possible (fig. 41). This has led to the sale of contaminated meat and meat products to unsuspecting public, with very high risks of zoonotic transmission of tuberculosis (Cadmus 2001) and other diseases.

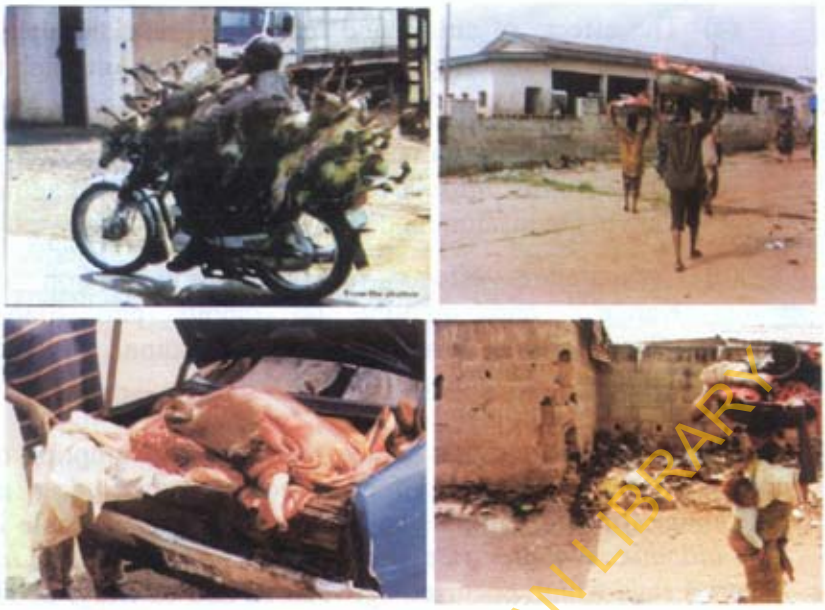

Fig. 41: Unhygienic ways of transportation of slaughtered meat.

Indiscriminate dumping and bad management of refuse, human and industrial wastes have serious environmental impact on livestock production systems which cannot be easily or justifiably quantified. Ikem (1996) found high levels of chemical oxygen demand, dissolved and suspended solids, ammonia, Pb, Fe, Ni, Cr, Mn, Cd and pH, and very high coliform counts in soils, streams, wells and boreholes around waste dump sites in two cities - Ibadan (Orita Aperin and Ring Road) and Lagos (Oworonsoki). These water bodies are major sources of drinking water to inhabitants (including animals) in those areas.

Fertilizers, herbicides and pesticides have been generally abused in our agricultural systems to the effect that soil quality has been compromised. Chemical constituents of many of these fertilizers and herbicides have been reported to be bio-accumulated in plants and farm produce, and have caused considerable morbidity and mortality in animals, including fish as reported in our studies highlighted below:

(a) The effects of single and repetitive oral administration of common pesticides and alcohol on rabbits (Fadina, Taiwo and Ogunsanmi 1999).

(b) Toxicity of gamma-benzene hexachloride (γ-BHC) to *Oreochromis niloticus* (Pisces: *Cichlidae*) (Fadina, Taiwo, Ogunsanmi and Agbede 2000).

(c) Comparative effects of oral administration of Karate$^{(R)}$ and nicotine on rabbits and tilapia (*Oreochromis niloticus*) (Taiwo, Fadina, Agbede, Faturoti and Ogunsanmi 2000).

Also improper dumping or handling and the consumption of chemically preserved/stored foods (mostly grains) serve as poisonings for both animals and man. A popular example is the *Indomie Noodle* (De-United Foods Industries Ltd, Nigeria) saga which occurred between 12 and 15 May, 2004, when sporadic cases of gastroenteritis and deaths were reported from human consumption of improperly treated chemically-preserved corn for the production of the *noodles*. This led to the temporary closure of their factories by NAFDAC.

Heavy fertilization with nitrogenous compounds and the use of certain herbicides have been reported to markedly increase nitrite and nitrate contents of plants, and these have been shown to cause varying degrees of tissue hypoxia, and may lead to cardiovascular and renal disorders and death in relatively high concentrations. Unguarded importation and use of N_2-based fertilizers and herbicides for agricultural purposes have revealed that farm produce from such practice, contain bio-accumulated residues of chemicals that can be potentially dangerous to consumers (both man and animals).

Oil prospecting and extraction have caused livestock, fish and other marine life genocide due to pollution by oil spillages and shock wave destruction from dynamites and explosive charges used in seismic activities (Ibeakuzie and Bereiweriso 1993). Many hectares of coastal lands and

polluted areas have suffered severe erosion, oil sludge encroachment and colossal loss of flora and fauna. The loss of aquatic resources, due to mortalities and horizontal transmission of pollutants to man, and the economic and public health implication are just imaginable but very huge. Olarinmoye et al. (2009), reported among others, severe hepatic pathologies in the brackish water catfish (*Chrysichthys nigrodigitatus*) from contaminated locations along the Lagos, Epe and Lekki lagoons in Lagos State. Productive fishing and potable water has continued to be an enigma to human and animal populace in areas severely polluted by crude oil and oil effluents. As a result of these hardships, there have been deadly uprisings by restive youths, economic sabotage, violent, often fatal, political unrests, assassinations and threats of secession by the oil-rich Niger Delta communities in Nigeria.

Environmental Lead Poisoning

Vice-Chancellor Sir, I will not finish this lecture without talking about a very serious and emerging "environmental zoonosis", which is poisoning by lead and other heavy metal wastes, in our environment. Lead is a naturally occurring toxic metal found in the Earth's crust. Its widespread use has resulted in extensive environmental contamination, human (and animal) exposure and significant public health problems in many parts of the world (Anetor et al. 2008; Human Rights Watch 2011). Important sources of environmental lead contamination include mining, smelting, manufacturing and recycling activities, and, in some countries, the continued use of leaded paint and leaded gasoline. Nigeria is one of the countries that use heavily leaded petroleum products. More than three quarters of global lead consumption is in the manufacture of lead-acid batteries for motor vehicles. Lead is also used in many other products, like pigments, paints, solder, stained glass, crystal vessels, ammunition, ceramic glazes, jewellery, toys and in some cosmetics and traditional medicines. Drinking water delivered through lead pipes or

pipes joined with lead solder may contain lead. Much of the lead in global commerce is now obtained from recycling (WHO 2014).

Young children are particularly vulnerable to the toxic effects of lead (Anetor et al. 2008) and can suffer profound and permanent adverse health effects, particularly the development of the brain and nervous system. Lead also causes long-term harm in adults, including increased risk of high blood pressure and kidney damage. Exposure of pregnant women to high levels of lead can cause miscarriage, stillbirth, premature birth and low birth weight, as well as minor malformations.

Sources and Routes of Exposure

People can become exposed to lead through occupational and environmental sources. This mainly results from:

- inhalation of lead particles generated by burning materials containing lead, e.g. during illegal mining, smelting, informal recycling, stripping leaded paint and using leaded gasoline; and
- ingestion of lead-contaminated dust, water (from leaded pipes and contaminated water bodies), food (from lead-glazed or lead-soldered containers).

The use of some traditional cosmetics and medicines, such as "eye-glazer" dust (known as *Tiroo* in Yorubaland) can also result in lead exposure. Young children are particularly vulnerable because they absorb 4–5 times as much ingested lead as adults from a given source. Moreover, children's innate curiosity and their age-related "hand-to-mouth behaviour" result in their mouthing and swallowing lead-containing or lead-coated objects, such as contaminated soil or dust and flakes of decaying lead-containing paint. This route of exposure is magnified in children with pica, who may, for example pick away at, and eat, leaded paint from walls, door frames and furniture. The same scenario occurs when animals, especially cattle and goats, gnaw painted walls

or objects. Exposure to lead-contaminated soil and dust resulting from battery recycling and mining has caused mass lead poisoning and multiple deaths in young children in Senegal and Nigeria.

Lead Poisoning in Zamfara State, Nigeria

Zamfara is a mineral-rich state, with significant deposits of gold. The lead poisoning epidemic resulting from small scale, artisanal gold mining in Zamfara State in 2010 that led to the death of about 400 people, mostly children below five years of age, is one of the worst cases of heavy metal poisoning in Nigeria (CDC 2010). Gold mining in these areas began in the early 1990s, but prior investigation in some villages showed that most families did not begin gold ore processing until 2009-2010. In May, 2010, the Federal Ministry of Health assembled a multidisciplinary team consisting of representatives from the Nigeria Field Epidemiology and Laboratory Training Programme (NFELTP), Zamfara State Ministry of Health and the Centre for Disease Control and Prevention to investigate and unravel the cause of high infant mortality during the Expanded Polio Vaccination Programme the previous year. It was later found that lead poisoning was the cause of these mortalities. The Blacksmith Institute, an international not-for-profit organization, founded in 1999 and dedicated to solving life-threatening pollution in the developing world was invited by the Nigerian Government to assist in the removal of toxic lead.

In the affected areas miners crush and grind ore to extract gold, and in the process release dust that is highly contaminated with lead. Children in affected areas are exposed to this dust when working or playing in the processing site (fig. 42), or when their relatives return home covered with dust on their clothes and hands, and when the processing occurs in their home. Children are also exposed to this highly toxic lead in contaminated water and food sources (fig. 42). Their animals are also not spared (fig. 42).

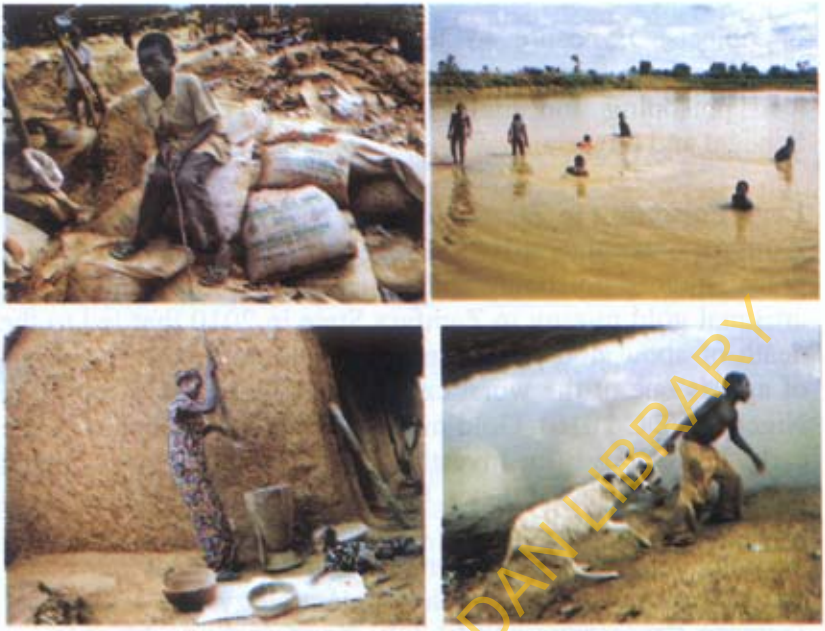

Fig. 42: Top left, A young boy sits on a stack of ore sacks in the mining processing site in Bagega village; **Top right**, children swimming on contaminated pond in the area; **Bottom left**, A woman grinds grain in a mortar and pestle while her child plays; **Bottom right**, a child takes a sheep to this highly contaminated pond to water and wash.

International partners, in cooperation with the Zamfara State Government, treated more than 1,500 children and cleaned up seven villages contaminated with lead. But there are thousands of children who reportedly still need treatment and thousands more who continue to be at risk for acute lead poisoning because their villages remain contaminated (WHO 2010). In Bagega, the largest and most contaminated village, environmental remediation and the implementation of safer mining practices to prevent recontamination were urgently needed and comprehensive treatment had to be provided for children. The Zamfara State government had started remediation in Bagega, but it reportedly lacks the resources necessary for an urgent comprehensive response. So the poisoning continues, not only there, ***but in hundreds or thousands of such illegal mining or processing sites all over Nigeria***. A very recent example is at the Rafi Local Government Area of Niger State where 28 children and many

animals (cow, goats, chicken) were reported dead due to lead poisoning as a result of artisanal gold mining in the area (Daily Independence, 14 May, 2015, pp. 1 and 4; fig. 43).

28 Children Die In Niger Lead Poison Outbreak

•Minister Blames Communities' Nearness To Mines

By Hassan Zaggi, Abuja

TWENTY-EIGHT persons, mostly children below the age of five, reportedly died in a fresh outbreak of Lead Poisoning in some villages in Riffi Local Government Area of Niger State.

The deceased, according to the Minister of State for Health, Professor Ifedayo Adetunji, were among the total of 65 cases recorded.

The villages mostly affected included Malgito and Kawo, which are near new mining sites found to contain more leaded ores often brought home for crushing and processing in the communities.

Nwaniowo, who addressed the media in Abuja, warned residents of the area to desist from eating affected cows and goats.

A breakdown of the figure

CONTINUES ON PAGE 4

Fig. 43: Excerpt from Daily Independence of 14 May, 2015.

Vice-Chancellor, Sir, while the remediation efforts were on for humans in the affected areas by our government and the volunteer international community, little or nothing was being done to find out the situation affecting the animal population in the areas, more so Zamfara State is not only a site of massive livestock production in this country, it is a livestock traffic route for animals trekked from Niger Republic and Chad down south to supply livestock for human consumption. Till date, I am not aware of any effort, by government and its agencies, State or Federal, to measure lead levels in animals and animal by-products such as the blood, meat, milk and milk products, and agricultural produce "exported" to other parts of Nigeria from the lead polluted areas of Zamfara State. That was what led my team to proceed to Bagega, Zamfara State, under very difficult and risky situations, to find out and evaluate the impact of lead poisoning and associated pathologies in one of our patients, the goat.

Our Zamfara Experience

We randomly sampled 282 naturally-exposed goats of both sexes, and 60 unexposed goats purchased from Tsafe, a non-gold mining village in Zamfara State. We also carried out laboratory investigations in 24 experimentally-exposed goats

given graded oral doses of lead, cadmium and lead+cadmium between 2010 and 2013. Six unexposed goats served as controls for the laboratory studies. Our results showed that heavy metal levels in blood and tissues of naturally exposed goats in Bagega were associated with hepatic, renal and brain injuries as a result of oxidative stress-induced tissue degeneration and necrosis (fig. 44). The results from the laboratory experiments were similar and the organ damage was dose-dependent and more severe with lead and lead+cadmium administration. We then concluded that high lead levels in the tissues of exposed livestock pose a very serious public health hazard to meat consumers. Some of these results have been published in the Ph.D. thesis of my student, Dr. Afusat J. Jubril which was successfully defended last month, and in some International Conference Proceedings in Ibadan, Ilorin and South Africa.

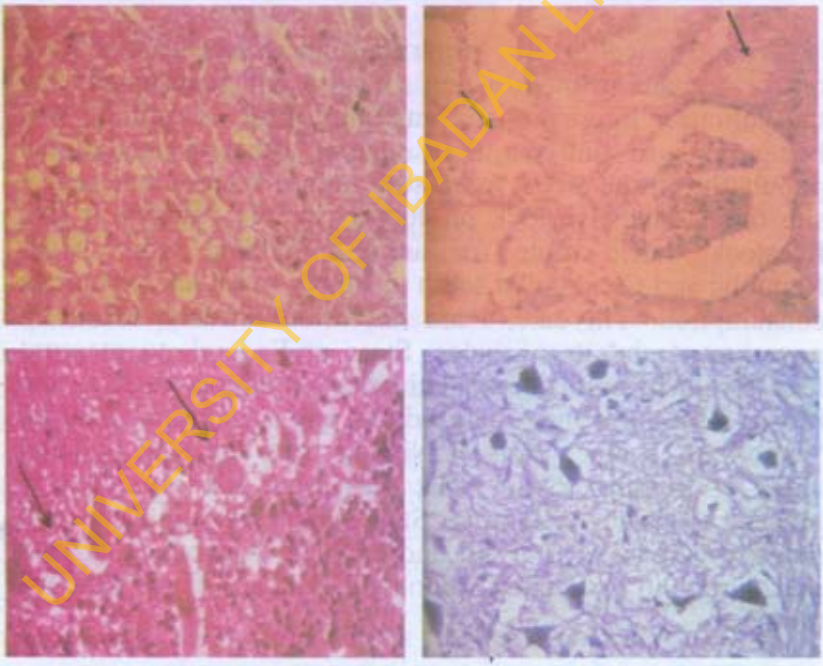

Fig. 44: Widespread hepatocellular vacuolar degeneration and necrosis (upper left); renal tubular and glomerular degeneration and necrosis (upper right); brain (cerebellum) with Purkinje cell degeneration and chromatolysis (lower left), and marked neuronal cell necrosis and spongiosis in the mid-brain (lower right) of goats exposed to lead pollution.

Vice-Chancellor, Sir, our results have confirmed previous reports that lead has serious consequences on the health and wellness of animals and man. At high levels of exposure, lead attacks the brain and central nervous system to cause coma, convulsions and even death. Children who survive severe lead poisoning may be left with mental retardation and behavioural disruption. At lower levels of exposure that cause no obvious symptoms, and that previously were considered safe, lead is now known to produce a spectrum of injury across multiple body systems. In particular lead affects children's brain development resulting in reduced intelligence quotient (IQ), behavioural changes such as shortening of attention span and increased antisocial behaviour, and reduced educational attainment. Lead exposure also causes anaemia, hypertension, renal impairment, immunotoxicity and toxicity to the reproductive organs. The neurological and behavioural effects of lead are believed to be irreversible (WHO 2014).

There is no known safe blood lead concentration (WHO 2015), but it is known that as lead exposure increases, the range and severity of symptoms and effects also increases. Even blood lead concentrations as low as 5 μg/dl, once thought to be a "safe level", may result in decreased intelligence in children, behavioural difficulties and learning problems (WHO 2014). It is also a known fact that continuous consumption of lead-contaminated food and water, even at low doses, leads to high levels of blood and tissue lead levels with attendant sequelae of health and wellness implications in man and animals.

The "*Macrophage*" in Man

Vice-Chancellor, Sir, from the fore-going discussions on my lecture titled, "Macrophages, Man and the Environment: My Life's Story", one or two things have been espoused; the Macrophage, like Man has been ordained and probably commanded by Almighty God to assume a divine role of controlling body homeostasis, disease prevention, mitigation and immune control in the body systems of living creatures, great and small. They, like Man, are also homogenously

heterogeneous and have specifically different nomenclatures, forms and functions in different tissues and organs in the body depending on the vagaries of their micro- and at times macro-environments. Like Man, they can decide to "do good" and uplift and protect their "host". They are also known to "do bad" by aiding invaders to adversely affect the health and wellness of their "host". Man was unequivocally given charge of the environment where God puts him. He was even given the duty to give names to all living things (*Gen. 2: 19, 20*). What an awesome duty! However, as we now know, ***Man is the ultimate destroyer of his environment, judging by the way he treats, uses, abuses and over-uses the environment's resources***.

Vice-Chancellor, Sir, would you believe me if I say that we are all Macrophages of some sort? I know you would be convinced that we all are. Let us ponder on the following:

(i) Is it not the same man (and woman) that gives birth to, nurture, gives love to and be ready to die for his/her offspring(s) that will turn round to harm, rape, or kill the same, at the slightest change in his/her environment?

(ii) Is it not the same man (and woman), who must retire from civil/public/private employment one day, but kept in charge (an enviable environment) of servicing Pensions/Gratuity Funds for retired workers, that will turn around to inordinately embezzle and plunder funds meant to take care of his older colleagues who have retired from service, some have even died while trying hard to collect their pension and gratuity, knowing fully well that his/her turn is fast approaching?

(iii) Is it not man (and woman) who should know the value of and sacredness of life and living, that will turn round to kill and maim other human beings, for no just reason than petty issues like religion, ethnicity, political and economic reasons (various environments)?

(iv) Is it not man (and woman) as an elected leader, put in charge of the welfare of its citizens, at any level of governance (environment) that turns round to impoverish, punish, misrule and glut on the commonwealth of the country or community?

(v) Is it not man (and woman) appointed as a Judge (a favourable environment), saddled with dispensation of justice with fairness and firmness, who turns around to collude with the wrong party to pervert justice and exonerate the guilty and punish the guiltless?

(vi) Is it not man (and woman) who was "ordained" a Priest/Reverend/Pastor/Bishop/Imam/Chief Priest, or in many other titles, who was "appointed" as a shepherd to cater for the spiritual and other needs of God's Sheep, turning around to become the devil's tool and devour the same "sheep" and lead them astray?

(vii) Is it not man (and woman), employed as a security agent, to guard and protect citizens or his/her employer that will turn around and invite or aid intruders to rob and kill his employer, at the slightest opportunity (environment)?

Vice-Chancellor, Sir, the situations are many and varied and we can go on and on to list hundreds and thousands of Man's Inhumanity to Man, not to talk of his compatriots, older than him by Creation, on Earth—the plants, animals and all other resources (air, land and water) meant to make life and living very good and secure for him until God says it is enough. Vice-Chancellor, Sir, I think that in any environment we find ourselves, let us endeavour to do good, unreservedly to ourselves and others within our environment lest we become the sharp knife that destroys its sheath (our environment).

Summary

Vice-Chancellor, Sir, I have been able to tell you and this august audience a little about my life history, academics, research, spiritual and temporal. I have been able to explain that the Macrophages and Man have been divinely ordained by God to take very good care of the environments where they have found themselves by divine placement. Considering the enormity of their responsibilities, the two-some have fared quite well in these tasks, securing good and healthy living, within the various environments, but we know that they also have run short of expectations in the performance of these tasks and have involved themselves in, in some cases, self destruction.

I have been able to showcase some of my research efforts aimed at ensuring food security and safety in this nation, and elsewhere, by our various studies into searching for alternate sources of foods and feed ingredients, ensuring their safety levels for both human and animal consumption, and for industrial uses. I and my various colleagues have also been able to research into and have highlighted some environmental toxicological issues affecting the health and wellness of man and animals in our environment, especially on use and abuse of pesticides and pyrethroids-containing insecticidal sprays and coils, and the effect of the Zamfara environmental lead pollution and its effects on our animals and possible effect on man. It is to be noted, Vice-Chancellor, Sir that Man accounts for more that 95% of all the causes of environmental pollution world-wide.

Man should note that he did not create his environment, and he did not choose wherever he found himself on Earth. He did not even choose whether to come as a plant, an animal or man. God did all that. Though man has been given the ominous right, by God, to modify his environment to suit some of his selfish requirements, I believe that God did not ordain man to destroy His creations. Man invents and discovers technology as God's sovereign gift; technology did not invent man. However, by the use of appropriate policies, crude or refined and purposeful, man has tremendous impact on his environment. Man can be likened to a parasite whose

success lies in his judicious and careful handling of his host – his environment. A successful parasite would not kill his host, or else it would also die. Since man has no other Planet to run to yet, the continued survival of man and his animals will depend on his ability to maintain a balanced ecosystem and sustainable resources to the benefit of both present and future generations.

Recommendations

The Role of Government and Policy Makers

Good and effective policies on technological advancement should be rekindled, especially in the agricultural sector to improve the handling of the little food we produce for consumption. Government, at all levels, should as a matter of urgency, review its Agricultural, Environmental Laws and Protection Policies and Strategies in the following areas:

- Revival of government input in agricultural storage and preservation systems by restructuring and strengthening its agencies involved in food storage and preservation; encourage private entrepreneurs who wish to go into food business, especially small-scale industries, acquire appropriate technologies, assist them with soft loans and easy tariff opportunities; and improve on the railway system of farm produce haulage to reduce waste due to breakdowns or accidents of haulage vehicles on our roads.
- A general overhaul of our Environmental Protection Policies and Technologies regarding oil exploration and spillage, air and water pollution by industrial wastes, urban waste disposal and management; and creation and enforcement of use of waste re-cycling plants at State and Local Government levels. This can be achieved by appropriate legislation and their enforcement. Government should strengthen our law enforcement agencies and judicial processes to enforce compliance with these laws so as to bring more sanity.
- Encourage the use of processed manure, human and such other wastes, rather than chemical fertilizers, all the time by farmers. Enough is enough of wasteful

spending of billions of Naira on further establishment and maintenance of Chemical Fertilizer Plants all over the country, which seem to be the order of the day.

- Education for all and sundry, especially for our youths, in community and personal hygiene. This should be entrenched in curricula of primary, secondary, tertiary and even vocational education in the country.
- Governments should encourage and adequately fund relevant tertiary biomedical and allied research institutes to carry out biodiversity studies and inventory of plant and livestock resources; setting up of gene banks, and genetic improvement of our plant and livestock species so as to keep the "keepables", for tomorrow and posterity.

The Role of the Individual

Individual families should use locally available old or new technologies to preserve and store food items such as yam, maize, etc and not engage in unproductive consumption of food. The individual should have a total change of attitude towards his/her environment. We are going to be held accountable for how we use or misuse our environment. That our total essence and survival depends on our environment is an over-statement. Every individual, high or low in the society, is guilty of his/her contribution to the present stage of our environment. It is all over there on our streets, air, water bodies; everywhere for us to see (fig. 45). As corrective measures, individuals should:

- Cultivate personal hygienic habits. Do not throw refuse or wastes just anywhere.
- Landlords, motorists (including private and commercial taxi/bus drivers) should provide adequate refuse disposal bins near within or near their houses and inside vehicles.
- Disciplined use of anything is imperative. Excess of everything is bad. Do not abuse or overuse anything. Excessive use of the common insecticidal sprays, rodenticides, herbicides and so on is dangerous.


Fig. 45: Refuse dumps along our streets.

Acknowledgements

If I had stood tall today, and have been seen or heard to have been inaugurated as a Professor of Veterinary Pathology, with a leaning to Toxicological and Environmental Pathology at this lecture today, it is because I have stood on the shoulders of "Giants" who individually and collectively have supported me along my life's journey. They are too numerous to mention, but I shall endeavour to list and briefly state their roles.

- My parents, Late Pa Michael Oladunni Taiwo (of Ajagunna Clan, Ojowo) and Late Madam Sabainah Adenihun Taiwo (nee Odubanjo, of Giwa Samosangudu Clan, Atikori), who, despite not being so educated and financially handicapped, did everything possible for me and my siblings to acquire good education. I am also eternally grateful to my maternal uncle, Late Oba Otubu Odubanjo, Keegbo I Atikori, Ijebu Igbo, who assisted my mother with my Secondary School Education at Molusi

College, Ijebu Igbo, and later single-handedly sponsored me through the early years of my under-graduate studies at the great University of Ibadan, Ibadan before I secured some scholarships. May God Almighty continue to rest their gentle souls in perfect peace. Amen.

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- My In-laws, Pa and Mama Ojeleke Aboyade, my wife's siblings, and the entire Aboyade Family of Awe. I knew

and got myself into the family, by *Divine Providence*, during my life's "dark moments". Despite the ominous cloud over me at those periods, they believed in me and God used them to present to me on a platter of Gold, a Helpmate, Mother and Confidant, well trained and packaged for me, when I needed such a help to rebuild my life.

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that at least, can "take us home" and make us feel like human beings who are contributing in no small measure to the economic and social development of this country. I salute our local ASUU, now and especially during the 1996/1997 session for their unflinching support to my family and I during my trying moments. My union trusted stayed with me even in the courts and ensured that no academic staff was ever so treated like I was by the Security Unit of this University at that time.

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- I thank all my other numerous friends and colleagues both within the University and outside. I thank you for always being there for me.

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- All Glory, Honour and Adoration to My Creator, Almighty God, our Lord Jesus Christ and Precious Holy Spirit who has kept me alive and well till this day and has done all these wonderful works through me and has preserved and sustained me till this very moment. Thank you Lord, in Jesus Name.

Mr. Vice-Chancellor, Dean, Faculty of Veterinary Medicine, I thank you for this great opportunity! Long live University of Ibadan, Long live Nigeria.

Thank you all for listening.

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BIODATA OF
PROFESSOR VICTOR OLUSEGUN TAIWO

Professor Victor Olusegun Taiwo was born six decades ago at Alekuso (C2) Area, Ibadan, Oyo State, Nigeria. He attended St. Luke's (now St. Matthew's I) Primary School, Ojowo and All Saints Primary School, Atikori, both at Ijebu-Igbo, Ogun State between 1960 and 1965. He had his secondary education at the famous *Molusi College, Ijebu-Igbo* between 1966 and 1970, after which he proceeded to the then Institute of Agricultural Research & Training (I.A.R. & T), University of Ife, Moor Plantation, Ibadan for a Diploma programme in Animal Health and Production, between 1971 and 1973. After working as Livestock Assistant/Higher Livestock Assistant in the then Remo Division of Western State, later Ogun State, Nigeria between October 1973 and August 1977, he gained concessional admission into the University of Ibadan to study Veterinary Medicine (his dream profession) after two previous unsuccessful attempts. He obtained the Doctor of Veterinary Medicine (D.V.M.), with Distinctions in Veterinary Pathology, Veterinary Clinical Pathology, and Veterinary Public Health and Preventive Medicine in 1983.

During his DVM programme, he bagged several scholarship/academic awards and prizes, such as Federal Government of Nigeria Merit Award (1979-1983), Departmental Prizes for Veterinary Pathology (1981), Veterinary Microbiology & Parasitology (1982), and Veterinary Public Health & Preventive Medicine (1983), and all the Faculty and University prizes for the best student in his graduating class, including NUPEMECO Prize for the best all-round student in the Faculty of Veterinary Medicine (1983), University of Ibadan Senate Prize for the best final year student in the Faculty of Veterinary Medicine (1983) and COOMASSIE Prize (endowed by Mallam Ahmadu Coomassie, O.B.E.) for the student with the highest marks in the DVM final degree examination (1983).

He was awarded Research Fellowship Awards by the International Laboratory for Research in Animal Diseases

(ILRAD, now ILRI), Nairobi, Kenya to carry out the research work for his M.Vet.Sci. degree (1986-1987), and doctoral research (1988-1992) leading to the award of a Doctor of Philosophy (Ph.D.) degree at the University of Ibadan in 1993. He was employed as Lecturer II in the Department of Veterinary Pathology in September 1992, and rose to the rank of Professor in 2006. He has taught Veterinary Pathology to undergraduate and postgraduate students and has supervised and examined many Master's and Doctoral students at the University of Ibadan. He was awarded the Membership of the Nigeria College of Veterinary Surgeons (MCVSN) in 2004, and Fellowship (FCVSN) in 2013. He has been a Consultant Pathologist to the Veterinary Teaching Hospital, University of Ibadan, Nigeria since 2003.

Professor Taiwo has served the Faculty of Veterinary Medicine, the University of Ibadan, Veterinary Council of Nigeria (VCN) and other bodies in various administrative capacities.

Some of these include:

- Sub-Dean (Undergraduate), Faculty of Veterinary Medicine, University of Ibadan (August 1994 – July 1996).
- Member of Senate, University of Ibadan (July 1995 – June 1999).
- Assistant Warden, Tedder Hall, University of Ibadan (April 1998 – May 2000).
- Sub-Dean (Postgraduate), Faculty of Veterinary Medicine, University of Ibadan (August 1998 – July 2003).
- Member, Administrative Committee of the Veterinary Teaching Hospital, University of Ibadan (August 1998 – July 2003).
- Member, Finance Committee of the Postgraduate School, University of Ibadan (August 2000 – July 2005; and August 1, 2009 – July 31, 2013).

- Member, Committee on Information and Communication Technology (ICT), University of Ibadan (August 2001 – August 2003).
- Sub-Dean, Postgraduate School, University of Ibadan (August 2003 – July 2005).
- Congregation Representative and Chairman of Panel "H" on the Senior Staff Disciplinary Committee, University of Ibadan, Ibadan (October, 2008 to date).
- Professor and Member of Senate, University of Ibadan (October 1, 2006 to date).
- Dean, Faculty of Veterinary Medicine, University of Ibadan (August 1, 2009 to July 31, 2013).
- Head, Department of Veterinary Pathology (August 1, 2013 to date).
- Chairman, Faculty of Veterinary Medicine Appointments and Promotion Panel (Parts I & II), August 1, 2009 to July 31, 2013.
- Member, University Appointments and Promotion Committee, University of Ibadan (2009 to date).
- Member, Research Management Sub-Committee of the Development Committee, University of Ibadan (2009 to 2013).
- Member, Veterinary Council of Nigeria (VCN) (August 1, 2009 to July 31, 2013).
- Member, Committee of Deans of Veterinary Schools in Nigeria (August 1, 2009 to July 31, 2013).
- Chairman, VCN Examinations and Registration Committee, (October, 2011 to July 31, 2013).
- Member, National Livestock Development Committee (NLDC) (2009 to 2013).
- Member, Animal Welfare Initiative, Nigeria (May 2009 to date).
- Chairperson, University of Ibadan Animal Care and Use Research Ethics Committee (ACUREC) (January 1, 2014 to date).
- Hall Master, Tedder Hall University of Ibadan, Ibadan (October, 2014 to date).

Professor Taiwo has taught, supervised and/or examined undergraduate and postgraduate students at the University of Maiduguri, Ahmadu Bello University, Zaria, University of Nigeria, Nsukka since 2005 till date. He has supervised numerous undergraduate students' projects, 12 Masters' dissertations and four Doctoral theses at the University of Ibadan. He has travelled far and wide on numerous trips within the country and abroad on local and international Conferences and Training Workshops to Ghana, Kenya, Amsterdam, Ivory Coast, Malaysia and USA. He has served as both Internal and External Assessor for Promotions to Professorial cadres in various Faculties within the University of Ibadan and other Universities outside Ibadan and Nigeria, notably Kwame Nkuruma University of Science and Technology, Kumasi, Ghana. He has published a total of 100 publications, including 76 journal articles, 14 peer-reviewed conference proceedings, one book and co-edited 9 books.

Professor Taiwo is happily married and has five boys (Segun, Jr., Bunmi, Ayo, Sola and Gbenga) and two girls (Modupe and Mayowa) and a grandson, Damilare.

NATIONAL ANTHEM

Arise, O compatriots
Nigeria's call obey
To serve our fatherland
With love and strength and faith
The labour of our heroes' past
Shall never be in vain
To serve with heart and might
One nation bound in freedom
Peace and unity

O God of creation
Direct our noble cause
Guide thou our leaders right
Help our youths the truth to know
In love and honesty to grow
And living just and true
Great lofty heights attain
To build a nation where peace
And justice shall reign

UNIVERSITY OF IBADAN ANTHEM

Unibadan, Fountainhead
Of true learning, deep and sound
Soothing spring for all who thirst
Bounds of knowledge to advance
Pledge to serve our cherished goals!
Self-reliance, unity
That our nation may with pride
Help to build a world that is truly free

Unibadan, first and best
Raise true minds for a noble cause
Social justice, equal chance
Greatness won with honest toil
Guide our people this to know
Wisdom's best to service turned
Help enṣhrine the right to learn
For a mind that knows is a mind that's free