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ENCOUNTER WITH MICROBES NO VICTOR, NO VANQUISHED

BY

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72ND INAUGURAL LECTURE

OLABISI ONABANJO UNIVERSITY
AGO-IWOYE

Tuesday, 13th October 2015.

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Mr. Vice-Chancellor Sir,
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The Provosts and Deans
The Professors and Heads of Departments,
The Royal Highness & Kabiyesi here present
My Lords Spiritual and Temporal
The Invited Special Guests far and near
The Press and News Media
Distinguished Ladies and Gentlemen
Staff and Students of OOU
Great, Greater and Greatest OOUITES !!!

Opening

Mr. Vice-Chancellor Sir, Professorial Inaugural lecture is at the heart of Olabisi Onabanjo University's reputation and a bi-monthly academic activity. The Inaugural Lecture is an opportunity for newly-promoted or appointed Professors to inform colleagues in the University and the general public, about their research careers so far and to update people on their current and possibly future research directions. The inaugural lecture is, therefore, a platform for professors to contribute to the academic life of the university and to take the **"gown to town"** through a public lecture.

I consider it a real honour to grant me permission to deliver the 72nd Professorial Inaugural Lecture of this great citadel of learning – Olabisi Onabanjo University, a tertiary institution named to immortalize the name of a great man who was the first Civilian Governor of Ogun State, which was created in 1976.

I share in the view that an inaugural lecture is a debt a Professor

owes the University Community and the Public at large and which must be paid at some point during his/her career.
Mr. Vice-Chancellor, I thank you for this opportunity. I am happy and will have a feeling of fulfillment when this assignment, which I have been looking forward to carrying out, is completed. Then I will as in the Holy Scripture take a deep breath and say: "It came to pass". My lecture titled **"Encounter with Microbes: No Victor, No Vanquished"** is the 72nd Professorial Inaugural Lecture here in Olabisi Onabanjo University, 7th from the Faculty of Basic Medical Sciences and 2nd from the Department of Medical Microbiology and Parasitology since the inception of this great citadel of teaching, learning and researching.

1. Preamble

Mr. Vice-Chancellor Sir, life on Earth would not have been possible without microorganisms, which are simply called microbes. It would have been impossible for humans to obtain plant proteins from leguminous plants like soya-beans, groundnuts and melons without nitrogen-fixing soil bacteria such as *Azotobacter, Rhizobium* and *Klebsiella*. These plants would not grow without nitrates being formed by the soil bacteria. Also, without biodegrading actions of microbes, we would run out of the essential elements of carbon, sulphur and phosphorus. Neither would there be a source of Vitamin B_{12} for all mammals including humans (Javor, 2004).
Microbes are organisms, which are too small to be visible to the naked eyes. Microbes include: bacteria, some fungi (e.g yeasts, some moulds), protozoa and viruses. "Microbiology is the science or the study of microbes. Microbiology as a field of specialization in Medicine is referred to as Medical Microbiology. It is mainly concerned with the isolation and identification of microbes that cause various infectious diseases in human beings. The antimicrobial susceptibility of the microbe(s) isolated from a clinical specimen is usually determined to assist the physicians in prescribing appropriate antimicrobial agents in the process of

treating infectious diseases. Therefore, a certified person who has acquired adequate academic knowledge and professional skills in the field of laboratory diagnosis of causative agents of infectious diseases is referred to, anywhere in the world, as a Medical Microbiologist.

Mr. Vice-Chancellor Sir, this clearly justifies my standing before the distinguished audience to give account of my teaching and research encounters with microbes at Olabisi Onabanjo University since I joined the services of this unique University on the 2nd October, 1985 as a pioneering Assistant Lecturer. I very much appreciate this privilege given to me to use this lecture to mark my **30 years** of meritorious service to the university. The month of October appears to be very special to me and to all Nigerians. First, Nigeria as a country obtained her national independence in October 1960 when I was about to leave primary school. Second, I secured an employment as a pioneering Assistant Lecturer in Pathology Department of the then Ogun State University in October 1985 under the leadership of our highly committed Head of Department in person of Professor Olukayode Dada who came from the University of Ibadan. Third, it was in October 1987, my better half took me to her parents in Lagos to present me as her sweet heart before we eventually got married in April (my birth month) in 1988. Fourth, I find myself today also in October standing before distinguished audience to give my Professorial Inaugural lecture, thereby turning my dream to a reality.

2. Microbes & Microbiology in Creation

Javor (2004) listed microbial signatures in the Holy Bible to show that there are terms in the Bible with direct links to microbial activity (Table 1.0). I will not be surprised if similar evidences could be found in the Holy Koran. The Almighty God created air, water, soil, plants and animals before creating man in His own image in form of male and female. He created all those living and

non-living things for a specific purposeto benefit humans (Genesis 1:1-31).

Microorganisms (or simply microbes) are bacteria, yeasts and moulds which are plants; protozoa which are animals while viruses are controversially classified as microbes, which are non-living/living things. If that is so, it is expected that microbes should be more adapted to this earth than man. Also, because of the fall of man in the garden of Eden due to his disobedience to the commandments of the Almighty God, man becomes prey to the microbial activity which is supposed to benefit him (Genesis 3: 1-24). I believe it is because of the fall that microbial infections of man now lead to the current deadly emerging and re-emerging infectious microbial diseases including: malaria, tuberculosis, typhoid fever, shigellosis, Ebola Virus Disease (EVD), Acquired Immunodeficiency Syndrome (AIDS) and opportunistic mycotic diseases such as oropharyngeal and cutaneous candidiasis, aspergillosis; subcutaneous mycosis e.g. sporotrichosis; systemic mycosis e.g. coccidiomycosis and superficial mycosis e.g. pityriaris versicolor to mention a few.

Table 1.0 Microbial signature in Bible

Biblical Term	Frequency in KJV	Text sample
Bread	335	Genesis 14:18
Boil	23	II Kings 20:6
Cheese	3	Jobs. 10:10
Consumption e.g. tuberculosis	5	Leviticus 26:16
Dough	8	Hosea 7:4
Dysentery e.g. bloody flux	1	Acts 28:7-8
Fever by malaria	9	Matthew 8:14
Leprosy	65	II Chronicles 26:19
Plague by Yersinia *pestis*	118	Numbers 14:37
Vinegar	11	Ruth 2:14
Wine by yeast	214	Mark 15:23

Source: Compiled from Javor (2004)

3. Divine Order leading to change of surname and status.

Mr. Vice-Chancellor Sir, human life is full of changes, some of the forces leading to the changes are above human control. A change is a process by which a person or something becomes different. A change for the better is always desirable to a person or to an institution. For example, our university changed its name from Ogun State University to Olabisi Onabanjo University to immortalize the name of the first civilian Executive Governor of Ogun State who contributed immensely to the establishment of this unique University which is meant to evenly develop Ogun State through the operation of a multi-campus system in all the four geopolitical zones of the state. The mission of the founding fathers of our university is to make it the "People University" in which the academic will take the "gowns to towns".
Our institution is the first university to have such a noble mission.
In another scenario, a divine Order came to me in the dream on Monday November 9, 2009 at 15 minutes past 12:00 midnight to change my surname from Ogunledun with which I obtained all my academic credentials to Oluwadun. When I woke up, I saw it, and I still see it, as a well come change in my life that I have to contend with. So, I quickly obeyed the divine Order and put notice of change of my surname in the Nation Newspaper of Wednesday November 11, 2009 for the Olabisi Onabanjo University Council and general public to please take note. Indeed, I thank the Council and Management of this University for accepting my change of surname which led to a positive turning point in my life leading to a speedy attainment of apex of my academic career. Today, I return all the glory to the Almighty God for giving me the grace to obey the Order, which definitely changed my 16 years stagnation as a Senior Lecturer since 1993 in this university to a Professor in year 2009; a change of status that ordinarily should have taken 5 to 6 years in any university in the world if there were no stagnating force.

4. Definitions of the word Encounter

The word encounter has various meanings depending on the usage. The Oxford Dictionary defines the word encounter as an unexpected or casual meeting, a confrontation or unpleasant struggle. The Encarta dictionary defines encounter as, to be faced with major problems, which are difficult to deal with or to meet somebody in conflict with hostility or aggression. Mr. Vice-Chancellor Sir, all these definitions of the word encounter are relevant to my research experience on microbes.

5. A personal Journey into Microbiology

In 1969, I had a serious fever of undetermined causative agent while on duty at the Electricity Corporation of Nigeria (ECN), Ijora Power Station where I was working then as a Laboratory Assistant determining the hardness of turbine boiler water, viscosity and ash content of gasoline. I was rushed to the Staff Clinic where my finger pricked blood was smeared on a glass slide, stained and examined under a monocular compound light microscope by a professional laboratorian in the Staff Clinic. The physician waited to receive the laboratory test result on which he based his prescription of drug that brought a relief to me within 3 to 4 hours after using the prescribed drug. This single incident made me to develop interest in studying a degree programme in the university that will give me the skill to determine the various causes of infectious diseases in humans. It also made me to register for a combination of Physics, Chemistry and Zoology for a part-time London Advanced Level General Certificate course at the Federal School of Science, Onikan, Lagos in 1969 to 1971 instead of Mathematics Physics and Chemistry, which could have prepared me for a degree programme in Industrial Chemistry.

However, my first sight of a dead body known as cadaver given to my group to dissect as 200 Level BSc. Health Science Medical student in 1974/1975 at the Faculty of Health Science of the then University of Ife (now Obafemi Awolowo University) made

another turning point in my life. Apart from my gradual loss of interest in a course that would force me to study the Anatomy of human dead body for 12 to 18 months, I also started seeing human dead bodies in my dreams. Furthermore, I ran out of money, which I saved while working to sponsor myself to University of Ife. Consequently, I found myself unable to pay 10kobo for breakfast, 15kobo for lunch and 15kobo for dinner at Fajuyi Hall cafeteria. So, I became one of the regular customers of the campus "bukateria" where I spent less than 10k per day as against the highly subsidized 40kobo meal per day in the University cafeteria.

In order to survive, I found myself participating in the long vacation job of Operation Feed the Nation (OFN) organized by the then Head of State, General Olusegun Obasanjo, for undergraduate students on long vacation. As I could no longer cope financially and emotionally with the demands and challenges in the medical school I had to sell my expensive hard cover Gray Anatomy text book to a classmate, S. O. Oguniyi, who today is a Professor of Obstetrics and Gynaecology and a former Provost of the College of Health Sciences at Obafemi Awolowo University. Consequently, I had to change to BSc degree programme in Microbiology, which is very related to my passion, in the same University.

6. Encounter with Rhizobium:

Encounter with Rhizobium as a Nitrogen Fixator

In the early 1960s and up to late 1980s when Nigeria was an active agrarian country, there was an increasing indiscriminate use of chemical pesticides in treating the seeds of legumes before planting. The users were largely illiterate farmers. Though the application of pesticides increased crop yields, the viability of nitrogen-fixing bacteria in soils was often adversely affected by the usual doses of pesticides. This problem of nodulation failure resulting from the treatment of seeds with pesticides led Odeyemi and Ogunledun (1981) to investigate the action of 6 different pesticides on the rhizobia of cowpea and soybean isolated from

various locations in Nigeria by estimating the growth of nitrogen-fixing bacteria turbidimetrically in the presence of increasing concentrations of each pesticide.

We reported that mercury containing fungicides were most toxic to Rhizobia, followed by chlorinated hydrocarbon pesticides while carbamate, tin-containing pesticides and bipyridinum pesticides were less inhibitory to the bacteria. We recommended that mercury-containing pesticides should be used with extreme caution, if not totally banned, in Nigeria because of their high toxicity while the use of pesticides such as gramoxone, brestan and dibam, which were found less toxic were considered reasonably safe pesticides. The publication is a product of my final year BSc degree programme in 1977/1978 at the then University of Ife and now Obafemi Awolowo University, Ile-Ife. Less did I know in my undergraduate research project that I was actually playing a friendly role in my first research encounter with microbes by creating public awareness on the harmful effects of indiscriminate use of toxic pesticides and fungicides on nitrogen fixing bacteria.

This humble contribution to knowledge fetched me Ogun State Government Oversea scholarship to do a Masters (MSc) degree programme in Microbiology at Texas Southern University Houston, Texas in USA in 1981.

7. Encounter with Aspergillus:

7.1 Aspergillus as an opportunistic pathogen.

A paradigm shift occurred at Masters degree research due to the counsel received from my host, Professor J. Perry, who housed me for the first four months off campus due to my late arrival by three days in the US and consequently could not meet registration for the 1981/1982 Fall Semester. He linked me to Prof. Sunday Fadulu, a renowned Mycologist who is a Nigerian-US citizen actively doing research on fungi belonging to the genus Aspergillus. There was no faculty member at my hosting University at that time working on nitrogen fixing bacteria *(Rhizobium* spp) and pesticides probably because the abused use of pesticides was not a big issue then in the

US as their farmers were mostly enlightened on good agricultural practices. However, Aspergilli are among the most abundant and widely distributed organisms on earth. They have evolved a myriad of metabolites, which have been biotechnologically exploited and patented by humankind. A number of Aspergillus related patents have been issued for medicinal compounds. The greatest positive economic impact of Aspergilli in the US has been in the exploitation of the enzymes and acid, which such as amylases and citric acid have a market value of more than $100 million per year (Berka *et al.,* 1992), Microbial amylases are used to hydrolyze the starch in grains such as corn into sugars while citric acid is used to impart a pleasant acid taste to foods and beverages.

Unfortunately, the negative public health and medical impacts of Aspergilli and their metabolites seem to be more than their positive economic impact. Some species are human and animal pathogens and some are allergenic. Most opportunistic and allergic human diseases, known as aspergilloses, are associated with immunosuppression. Aspergilloses caused by *Aspergillus fumigatus* are frequently fatal among the immunosuppressed people and cancer patients while aspergillus-associated allergies are regularly reported among apparently immunocompetent people (Latge, 1999). The Houston Chronicle newspaper (1983) reported that mycotic disease due to *Aspergillus fumigatus* was responsible for the death of some cancer patients in New York and the infection was linked to air conditioning. That implies that under certain circumstances, man is exposed to inhalation of great numbers of conidia of moulds such as *A. fumigatus*, which may result in a fatal mycotic disease known as pulmonary aspergillosis.

My ardent search for the virulence factors of this opportunistic pathogenic fungus among the non-polar toxins coupled with my desire to elucidate the pathogenesis of its infection ushered me into my second encounter with a microbe, this time a filamentous fungus known as *Aspergillus fumigatus*, which hitherto in Nigeria, I regarded as a mere saprophyte. Of great challenge are the repeated

observations that the genetic expressions such as colour of conidia and growth rate of *Aspergillus fumigatus* vary depending on the growth media utilized and method of cultivation. Thruston *et al.*, (1973) applied peptone dialysate medium to grow this opportunistic pathogenic mould and obtained excellent yield of toxins from spores, mycelium and culture filtrate. Also, Longbottom (1974) obtained luxuriant growth of *A.fumigatus* with abundant yield of toxic extracts by using surface cultures and Sabouraud's dextrose medium. However, these two media were not considered ideal for isolation of fungal toxins, especially as they relate to skin testing, since peptone in the media is the principal nitrogen source and the media do not adequately simulate *in vivo* conditions to produce authentic toxins.

By modification of Asparagine Synthetic Medium (ASM) by including whole canine blood and by incubation at 37°C, I obtained rapid and luxuriant growth of *Aspergillusfumigatus* (Ogunledun, 1984) in my MSc research at Texas Southern University under the supervision of Professor Sunday O. Fadulu. My Enriched Synthetic Medium (ESM) closely simulated in*vivo* condition because it contained all the components of canine blood and also the incubation temperature of 37°C is the normal body temperature of humans.

When a study of the comparative growth rates of *A.fumigatus* and yield of the non-polar toxins of this organism was conducted, I obtained a reproducible, rapid and luxuriant growth of the organism coupled with a higher yield of its non-polar toxins. The results obtained in my ESM contrasted with the highly variable and slow growth ordinarily observed in ASM without the modification. Further, a higher toxicity was found to be associated with the contents of the ethyl acetate extract of the mycelia from my ESM. It was concluded from the findings of the study that ESM produces a more efficient yield of non-polar toxic compounds of *A.fumigatus*.

7.2. Aspergillus as a contaminant of environmental and food commodity

*Aspergillus*species are widespread in the environment and are commonly found as contaminants in hospital wards and in food commodity. Adeyemi (2011) reported 41.7% frequency of occurrence of *Aspergillus fumigatus*among the fungi isolated from hospital wards in Ibadan, Nigeria. The ability of this mould to adapt to broad ranges of environmental condition may account for its cosmopolitan and ubiquitous occurrence in soil, plant debris and indoor air environment.

Jayeola and Oluwadun (2010) reported 25.0% frequency of occurrence of *Aspergillus niger* in some cocoa powders. The results obtained by these workers confirmed the earlier report by Ogunledun(2007) that *Aspergillus* species constituted the predominant moulds isolated from cocoa-based beverages. Similarly, we reported *Aspergillus* as the most predominant fungi associated with deterioration of a traditional fermented cassava product (garri) in Ogun State, Nigeria (Thomas *et al.*, 2012). In another study carried out to determine the relationship between the intrinsic factors and aetiology of rot in Irish potato (*Solanum tuberosum. L*) purchased in Lagos, we found *Aspergillus niger* to have an isolation rate of 23.0% (Akinleye *et al.*, 2013).

The major challenge, which man is facing is how to prevent this mould in human environment as it is now being widely implicated as an opportunistic pathogen in cancer and immunosuppressed patients and also in deterioration of agricultural food commodity.

8. Encounter with Malaria parasite

8.1 Prevalence and significance of symptomatic and asymptomaticmalaria parasitaemia in Sagamu

Malaria has probably exacted the greatest toll of human afflictions as it continues to make both the young and adults to fall sick and kill children under the age of 5 years more than any other infectious disease in Africa.Ogunledun *et al.* (1988) determined the prevalence and significance of symptomatic and asymptomatic malaria parasitaemia in Sagamu. Our results show that malaria is a

widespread tropical disease in Sagamu with a prevalence of 55.9 percent among symptomatic and 20.6 per cent among asymptomatic cases. We also discovered that the malaria parasite gametocytaemia is not influenced by age. We, therefore, conclude that both the young and adults are prospective agents of malaria transmission. Also we conclude that asymptomatic malaria parastaemia in blood transfusion could contribute to malaria transmission. We recommend that blood to be transfused should be checked against malaria parasite.

8.2 Relationship between malaria parasitemia and symptoms of the disease in adults

The diagnosis of malaria is made with certainty on identification of malaria parasite in blood films of the patient together with the other symptoms associated with the disease. Due to the large and increasing number of patients attending the Medical and General Outpatients Department of the then newly established Ogun State University Hospital (OSUTH), Ogunledun*et al.* (1991) carried out a study to investigate the relationship between malarial paracitaemia and symptoms of the disease in adults.

We found that fever and nausea/vomiting were found to be more related to malaria parasitaemia than headache, cough, diarrhea and myo-arthralgia (Table 2). We also found no definite relationship between the density of parasitaemia and frequency of fever on one hand and nausea/vomiting on the other hand (Table 3). The parasite density, however, decreases with increase in age (Table 4). All these made us to believe that immunity may be playing a role in protection against malaria.

Table 2. Comparison between frequency of malaria – like symptoms in patients.

Symptoms	Parasitaemic: 108 Frequency/108 (%)		Aparasitaemic: 85 Frequency/85 (%)		X^2 Value	P Value
Fever	100	(92.6)	64	(75.3)	11.14	<0.001
Cough	17	(15.7)	13	(15.3)	0.01	>0.05
Headache	91	(84.3)	66	(77.7)	1.37	>0.05
Nausea/Vomiting	48	(44.4)	23	(27.1)	6.18	<0.05
Diarrhoea	7	(6.5)	7	(8.2)	0.20	>0.05
Myearthralgia	75	(69.4)	64	(75.3)	0.51	>0.05

Source: Ogunledun *et al.* (1991)

Table 3. Comparison between relative falciparium count and malaria symptom.

Relative falciparum count	Fever		Nausea/Vomiting	
	Number Positive	(%)	Number Positive	(%)
+	36	(39.1)	13	(29.5)
++	27	(29.4)	16	(36.3)
+++	4	(4.3)	2	(4.6)
++++	25	(27.2)	13	(29.6)
TOTAL	92	(100)	44	(100)

Source: Ogunledun *et al.* (1991)

Table 4: Relationship between parasitaemia density of symptomatic patients and their age group

Age Range (Years)	Density of Parasitaemia							
	+		++		+++		++++	
	n1	(%)	n2	(%)	n3	(%)	n4	(%)
10-19	13	(27.0)	12	(40.0)	2	(40.0)	16	(64.0)
20-29	20	(41.7)	9	(30.0)	1	(20.0)	9	(36.0)
30-39	6	(12.5)	3	(10.0)	1	(20.0)	0	(0)
40-49	4	(8.3)	2	(6.7)	0	(0)	0	(0)
50-59	3	(6.3)	4	(13.3)	0	(0)	0	(0)
60-69	1	(2.1)	0	(0)	1	(20.0)	0	(0)
70-79	1	(2.1)	0	(0)	0	(0)	0	(0)
80-89	0	0	0	(0)	0	(0)	0	(0)
TOTAL	48	(100)	30	(100)	5	(100)	25	(100)

Source: Ogunledun *et al.* (1991)

8.3 Malaria prevalence in relation to pregnancy

For the study of malaria in pregnancy as an expression of the breakdown of acquired malaria immunity, data of the endemicity of malaria in a study area have to be considered and malaria parasitaemic prevalence has to be compared in non-pregnant and pregnant women. Ogunledun*et al.* (1998) observed that there was paucity of work done on the effect of pregnancy on seropositivity to malaria circumsporozoite protein in Nigeria, West African where malaria is hyperendemic. Therefore, we used an ELISA employing a novel synthetic peptide consisting of 40 (Asn-Ala-Asn-Pro) repeats of *Plasmodium falciparum* circumsporozoite protein (NANP), which was considered then as a malaria vaccine candidate, to detect malaria antibodies in 214 non-pregnant and 242 pregnant women attending Ogun State University Teaching Hospital in Sagamu. All the 456 women were asymptomatic for malaria and were also investigated for malaria parasitaemia.The parasite rate of 60.3% in pregnant primigravidae was significantly higher than the 33.3% rate in non-pregnant primigravidae (X^2= 4.787, P<0.05). Also, the parasite rate of 31.6% in pregnant

multigravidae was found to be significantly higher than 19.4% in non-pregnant multigravidae (X^2 = 5.826, P<0.02)(Table 5).

Table 5. Comparative malaria parasite rates in pregnant and non-pregnant women

Gravidity	Pregnant Women			Non-Pregnant Women			X^2	P
	N1	Parasitaemic	%	N2	Parasitaemic	%		
Nulligravidae	0	0	(0)	66	18	(27.3)	-	-
Primigravidae	46	28	(60.9)	24	8	(33.3)	4.787	<0.05
Multigravidae	196	62	(31.6)	124	24	(19.4)	5.826	<0.02
Total	242	90	(37.2)	214	50	(23.4)		

Source: Ogunledun *et al.* (1998)

Furthermore, we found the 71.1% seropositivity rate in 90 parasitaemic pregnant women to be significantly higher than the 52.0% rate in 50 parasitaemic non-pregnant women (X^2= 5.113, P= 0.05) (Table 6)

Table 6. Comparative seropositivity rates of pregnant and non-pregnant women to malaria $(NANP)_{40}$ protein $(NANP)_{40}$

Parasitaemic Women	N	Seropositive	%
Pregnant	90	64	(71.1)
Non-Pregnant	50	26	(52.0)

X^2=5.113, P= 0.05

Source: Ogunledun *et al.* (1998)

These our findings show that pregnancy in women living in malaria hyperendemic community definitely increases their susceptibitlity to malaria circumsporozoite protein. Also, these findings suggest that pregnancy may influence the effectiveness of the then proposed malaria circumsporozoite vaccine in women. However,

in another study by Sule-Odu *et al.* (2002) to determine the impact of asymptomatic maternal malaria parasitaemia at parturition on perinatal outcome, we found no significant effect on the maternal and foetal wellbeing in parasitimic mothers when compared withmaternal and foetal wellbeing in aparasitaemic mothers at parturition.

Available evidence informs that the functional changes in erythrocyte membrane pumps due to pathophysiological challenges by *Plasmodium falciparum* in holoendemic populations are incompletely understood. A study was, therefore, undertaken by Iwalokun *et al.* (2002) to investigate and compare kinetics of digoxin sensitive (NaK)ATPase and Ca2+ATPase in erythrocyte membrane of symptomatic and asymptomatic falciparum malaria patients in Lagos. The results of the study support the indispensability of calcium in the intraerythrocyte development of *Plasmodium falciparum* and also report disparity in the kinetic of erythrocyte membrane pumps in asymptomatic and symptomatic malaria episodes in Lagos – Nigeria.

8.4 Osmotic fragility and platelet count in management of malaria

In Nigeria, acute *Plasmodium falciparum* is a threat to the life of children under 5 years (Sowunmi and Salako, 1992). Children in endemic communities, which scatter all over the country, experience an average bout of 4 malaria episodes per year (Iwalokun *et al.*, 1999). A significant proportion of children die from malaria complications including cerebral malaria and severe anaemia in conjunction with other haematological impairments such as thrombocytopaenia and raised fragility. Failure to treat majority of the malaria complication cases as emergencies has been given as one of the reasons for avoidable deaths in children (Elisha, 1987). Osmotic fragility, which is a red blood cell lysis syndrome arising from deformability in structure has been evaluated and found reliable in assessing the success of management of essential

hypertension in Nigeria (Fasanmade, 1999). Also, resolution of thrombocytopaenia has been found useful in monitoring drug success and recovery from acute malaria illness in other community (Leoareesuwan *et al.*, 1992).

Iwalokun *et al.* (2004), therefore, investigated the capacity of osmotic fragility measurement and platelet count determination as markers of recovery and drug success in the management of falciparum malaria in Nigerian children. We found that thrombocytopenia in severe malaria was significantly higher than that in uncomplicated malaria. At day 3 to 4 of treatment, parasitaemia became zero in all the malaria subjects but resolution of thrombocytopenia and osomotic fragility to normal was incomplete except in uncomplicated malaria. However, at day 10 after schizonticidal intervention, osmotic median corpuscular fragility (MCF) of all the malarial children fell within the normal range and were not significantly different ($P>0.05$) from that of healthy children.

Thrombocytopenia also reduced substantially from 100% to 14.30% in cerebral malaria, 34.1% to 7.3% in severe anaemia and 17.4% to 4.30% in uncomplicated malaria after schizonticidal intervention. We concluded that effective management of acute *P. falciparum* in Nigerian children is a combination of good therapeutic response and substantial recovery from acute illness, which can be adequately assessed by monitoring parasite clearance, osmotic fragility and platelet count patterns (Iwalokun, *et al.*, 2004)

8.5 Xanthine oxidase for monitoring treatment and outcome of malaria

Pathogenesis of falciparum malaria is well known to involve oxidative stress in which free radicals overwhelm antioxidant defense system of the host. However, information on the sources of oxidative stress and their potentials as predictive and prognostic biomarkers is essential for monitoring treatment outcome and

informing the need for adjunctive therapy. We, therefore, investigated xanthine oxidase (XO) activity among Nigerian children with falciparum malaria. Symptomatic children were screened for malaria parasites by microscopy followed by laboratory analyses of xanthine oxidase, catalase and liver function parameters, which include spectrophotometric determination of plasma levels of glutamate oxaloacetate and glutamate pyruvate transaminases (GOT and GPT) based on transamination and formation of hydrazones (Iwalokun *et al.*, 2006).

We found XO activity correlated positively with liver function parameters and severity of falciparum malaria in afflicted children. The enzyme activity declined rapidly in children with early clearance of parasitaemia making it to be a valuable prognostic marker. We, therefore, recommended the use of xanthine oxidase (XO) as a marker for monitoring treatment outcome and early recovery from malaria episodes.

8.6 Toll-like Receptor 4 (TLR4) and susceptibility to malaria

Toll-like receptor 4, a major pathogen recognition receptor (PRR) expressed on membrane surface of innate immune cells is genetically encoded by the TLR4 gene (Takeda *et al.*, 2003). This PRR is a well-established receptor for the toxins produced by microbes including *Plasmodium falciparum* and *Trypanosoma cruzi* as well as for lipopolysaccharide of Gram negative bacteria and other pathogens associated molecular patterns ($PAMP_s$) in Gram-positive bacteria, fungi and viruses (Takeda *et al.*, 2003).Case-control studies have established associations of *TLR4* Asp 299Gly or Thr 399Ile polymorphism with death from septic shock and susceptibility to typhoid fever, tuberculosis, meningitis, Chagas disease and respiratory syncytial virus infection in infected infants, children below 5years and adults (Lofgren *et al.*, 2010). However, findings from case-control studies in malaria endemic

countries regarding association of these polymorphisms with susceptibility to clinical and severe malaria have been contradictory. The discrepancies have been based on the differences in geographical locations and genetic background of human populations where the studies were conducted. Therefore, there is need for immunogenetic studies regarding the role of *TLR4* polymorphisms in malaria pathogenesis, particularly in countries with high malaria transmission.

Nigeria is currently among the high malaria burden countries in the world. Despite evidence from the HapMap project that the various genotypes of *TLR4* Asp299Gly and Thr 399 Ile SNPs are in circulation among the Yoruba tribe (IHC, 2005), the roles of these SNPs in influencing susceptibility to clinical and severe malaria remain unknown. It is on this basis that we carried out a study to determine the frequency, distribution and association of mutant genotypes of *TLR4* Asp 299Gly and Thr399Ile polymorphisms in a cohort of *P. falciparum* infected Nigerian children with susceptibility to clinical and severe malaria. Genomic DNA of the study participants was screened for the genotypes of *TLR4* Asp 299Gly and Thr 399Ile by PCR-RFLP. Anthropometric measurement was performed on the Pf infected children stratified into asymptomatic malaria (control), uncomplicated and severe malaria (case). Parasites were detected by light microscopy and Hardy Weinberg Equipment (HWE) of SNP genotypes was also determined (Iwalokun *et al.*, 2015). Our findings reveal that *TLR4* Asp 299Gly and Thr 399Ile polymorphisms may modulate susceptibility to severe malaria among Nigerian children of Yoruba ethnic background (Iwalokun *et al.*, 2015)

9. Encounter with pathogenic bacteria in asymptomatic people

The occurrence of bacteria in humans may sometime be asymptomatic and, therefore, make them vehicles of transmission

of agents of diseases. In one of our early studies on the nasal carriage of *Staphylococcus aureus* among the hospital personnel of the newly established Ogun State University Teaching Hospital, Olusanya *et al.,* (1991) found that 95.0% of the isolated organisms were resistant to Penicillin G. In another study, Olusanya *et al.,* (1992) reported 85.3% and 81.6% prevalence rates of bacteria, which were resistant to suphonamides and were isolated from the urine samples of pregnant and nonpregnant women respectively with asymptomatic significant bacteriuria.

A study was carried out to determine the microbial agents associated with parturient vagina and neonatal eye infections in Sagamu (Ogunledun*etal.*1993). We reported that over 90% of the parturient vaginas examined, harbored one or more types of microbes with coagulase negative Staphylococci followed by *E. coli*, being the most frequently isolated.We found that the membrane status of parturient women did not affect the rates of microbial colonization of their vagina and transmission to the eyes of their neonates. Also, Sule-Odu *et al.* (1998) reported that the frequency of isolation of these bacteria was predominant in parturient women with normal labour except *E. coli* which was associated with prolonged labour. In another study, Sule-Odu *etal.* (1999) determined effects of amniotic membrane status and duration of labour on vaginal microbes in pre-term delivery.

We concluded from the study that rupture of amniotic membrane does not significantly change the microbial colonization of parturient vagina in pre-mature delivery. The duration of labour was found to be significant factor affecting the microbial flora of parturient vagina in pre-term delivery. The study further concluded the transmission rate of microbes to the neonates depends on the duration of labour in pre-term delivery and in the oxygen requirements of the microbes.

10. Encounter with pathogenic bacteria in symptomatic people

10.1 Encounter with *Streptococcus pneumoniae*

Streptococcus pneumoniae is well known as one of the major causes of respiratory tract infections in Nigerian children below 5 years and adults who are immunocompromised. However, information on different types of strains of this pathogenic bacterium circulating in South West Nigeria is lacking for production of vaccines to prevent all diseases likely to be caused in man by this pathogen. Therefore, we carried out a study to determine serotype and clonal affiliations of *Streptococcus pneumoniae* strains isolated from patients attending four health centres in Lagos. The isolates were characterized, serotyped and their antibiotic susceptibility and genetic diversity were determined (Iwalokun *et al.,* 2012).

We obtained five distinct serotypes based on cell-wall serotype 19F of *S. pneumoniae* circulating and all within the coverage of 13 valent – pneumococcal conjugate vaccine (PCV-13). The isolates were susceptible to erythromycin and clindamycin. Random Amplified Polymorphic DNA (RAPD) reveals weak genetic similarity but heterogenous transmission of *Streptococcus pneumoniae* in South-West, Nigeria. We recommended integration of PCV-13 into the National programme of immunization as a strategy to reduce mortality of children under the age of five.

10.2 Encounter with Shigella

Shigellosis still remains a public health problem in most developing countries where communities are ravaged by poverty, war, poor sanitation, personal hygiene and safe water supplies. We reported the endemicity of shigellosis with *Shigella flexneri* as the predominant serogroup in Lagos (Iwalokun *et al.,* 2001,2002). We

found children and young adults to be at higher risk of severe shigellosis. Our results also revealed that over 70% of the Shigella isolates were resistant to two or more antibiotics including ampicillin and tetracycline. Furthermore, 21 distinct multidrug resistance patterns were observed in these isolates. When plasmidic speciation of the Shigella isolates from Lagos was determined, the plasmids generated 19 distinct profiles.We recomended nalidixic acid, ciprofloxacin and ofloxacin as drugs of choice for the treatment of shigellosis.

10.2.1. Haemagglutinin as virulence factor of Shigella

Haemagglutinins, which are ubiquitous proteinaceous adhesins with cell-agglutinating and adherence properties have been implicated to play a crucial role in the initiation and development of clinical symptoms and complications in shigellosis. Therefore, as a prelude to probable design of anti- Shigella vaccines for the Nigerian environment, we screened 45 local Shigella strains for haemagglutinins expression (Iwalokun *et al*;2003). The results of the study revealed broad-spectrum haemagglutination reaction inShigella strains circulating in Lagos. The adhesins, while displaying heterogeneity in haemagglutination property, also appear to conform to the requirement for complex carbohydrates for binding and cellular aggregation.

10.2.2 Shigella enterotoxins and epithelium handling of vitamin A, vitamin E and catalase

Knowledge on the pathophysiology of Shigella is crucial to development of novel control strategies. Unlike shiga toxin from *S. dysenteriae,* shigella enterotoxins are well recognized as secreted virulence factors in all Shigella serotypes. But their contribution to micronutrient depletion of the gut during the early watery phase of shigellosis remains unclear. There is also lack of data on the relationship between enterotoxins and gut antioxidant enzymes as well as the effect of these virulence factors on the homeostasis of

retinol and α-tocopherol in system circulation and extra-intestinal tissues. Unlike shiga toxin, the toxic effects of enterotoxins on cells is not well-known. A fuller understanding of the roles played by enterotoxins in the pathogenesis of Shigella infection in human is hoped to improve management of shigellosis and provide scientific justification for better and future Shigella anti-toxic vaccine construction.

Overnight culture filtrate of 23 Shigella isolates recovered from Nigerian patients were tested for enterotoxigenicity in mice coupled with the determination of intestinal, systemic and hepatic levels of retinol, α-tocopherol and catalase in the exposed animals (Iwalokun *et al.*,2007). We observed variations in enterotoxigenicity among the Shigella serogroups tested and loss of retinol homeostasis. We also observed growth inhibitory and cytopathic effects of the culture filtrate on caco-2-cells, suggesting the ability of enterotoxins to impair enterocyte growth and cause cell injury. We found that Shigella exposure significantly reduced intestinal levels of vitamins A & E and catalase activity. But these effects were less significant in mice fed diets supplemented with zinc, vitamin A and vitamin E in whom zinc correlated significantly with catalase activity.

We, therefore, recommend nutritional improvement of Nigerian children and rehabilitation of *shigella* infected patients with zinc, vitamins A and E.

11. Encounter with *Vibrio cholerae*

In Nigeria, cholera due to *Vibrio cholera* 01 E1 Tor has persisted as a public health problem since 1971 when the first epidemic was reported (Wilson, 1971). Nigeria has been plagued with seasonal epidemics of cholera with high mortality impact since 2007. Data to understand the molecular epidemiology of strains for developing country-specific control measures are either not available or incomplete in most of the epidemic states. To bridge this

information gap, we determined the phage type profiles of some selected *Vibrio cholera* 01 biotype E1 Tor strains involved in epidemic between 2007 and 2013 in nine states of the country (Akinsinde*et al.*,2014).

A total of 52 epidemic strains of *V. cholerae* from nine states: Abia, Bauchi, Kano, Gombe, Ilorin, Lagos, Ogun and Osun based on viability and positive serogrouping of 122 stock cultures were phage typed using both the old (two groups) and new (10 groups) typing schemes according to World Health Organization (WHO) guidelines. Findings from this study indicate that multiple phage types of *V.cholerae* 01 biotype E1 Tor with the predominance of T-27 are common in Nigerian cholera epidemic situation since 2007. This study also revealed phage multiplicity to play a role in the documented higher case fatality of 2010 cholera epidemics compared to recent outbreaks in the country (Akinsinde *et al.*, 2014).

12. Encounter with *Mycobacterium tuberculosis*

The occurrence of drug multi–resistant *Mycobacterium tuberculosis* among the HIV seropositive patients has raised global public health concern. We, therefore, determined the prevalence of multi-drug resistant tuberculosis (MDR-TB) among HIV seropositive and seronegative patients in Abeokuta, Nigeria (Ejilude *et al.*, 2013).

Out of 504 patients, 7.9% prevalence of HIV infection was recorded. Of 289 males, 11.4% was seropositive while 7.9% of the 215 females were seropositive. The occurrence(62.5%) of TB in HIV patients was found to be associated with HIV ($P<0.05$). The overall prevalence of multi-drug resistant *Mycobacterium tuberculosis* among TB patients was found to be 5.8%. MDR-TB was found to be significantly associated with HIV seropositive patients having 32% rate when compared to HIV- seronegative rate of2.2% ($P<0.05$).

From the study, we concluded TB prevalence was high among the studied population, while MDR-TB was relatively high in TB patients especially among the HIV seropositive patients. We recommended that the practice of screening HIV patients for TB should be continued.

13. Encounter with agents of dermatophytoses.

Dermatophytoses are diseases caused by fungi thatinfect the superficial keratinized tissues such as the hair,skin and the nails and arecaused by three genera of fungi collectively known asdermatophytes. Thedisease is widespread and socio-economically notorious (Raheem *et al.*, 2012). It isalso a major public health problem as it is a common infectious skin disease among the Nigerian primary school pupils (Popoola *et al.*, 2006). Transmission of thisinfection is mainly through direct and indirectcontact.The direct route of transmission is from animalto man or man to man whereas indirect route could befrom fomites to man. Information onwhether dermatophytosis can alter hematological parameters in the affected patientis scanty.

We,therefore, investigated theimpact of dermatophytoses on the hematological andbiochemical parameters of dermatophytic pupils invarious primary schools in Remo community, OgunState, Nigeria(Raheem *et al.*,2012). The research became imperativebecause of the increasing rate of this infection amongprimary school pupils and school age children in OgunState and of course in Nigeria.We found no significant difference in the mean PCV, Total WBC, neutrophil, lymphocyte, platelet counts and random blood sugar (rbs) between the pupils with dermatophytoses skin lesions and pupils without ($P>0.05$) while the Erythrocyte Sedimentation Rate (ESR) and Eosinophil count were significantly higher in pupils with dermatophytoses ($P<0.05$) (Raheem *et al.*, 2012).

14. Encounter with Human Immunodeficiency Virus (HIV)

Human Immunodeficiency Virus (HIV) is a plague afflicting the whole world. The risk of complications of blood transfusions had encouraged resisted and cautious use of blood. We carried a study to review the prevalence of the infection among blood donors in a University Hospital in Nigeria. Twelve (44.4%), 1 (3.7%) and 14 (15.9%) of the confirmed blood donors were infected with HIV 1, HIV 2 with a mean age of 31.0 ±5.5 years while those aged 30 – 39 years and 20 – 29 years constituted 59.2% and 33.3% respectively of the blood donor population Sixty six point seven percent (66.7%) and 64.3% of the blood donor infected with HIV 1 and 2 had blood group O respectively (Sule-Odu *el al.*, 1999).

We, therefore, recommended the need for routine screening of the blood donors for HIV infections. Also, we recommended that government should intensify actions on eradication of the virus and the disease by maintaining intense public enlightenment. The screening test should be made cheaper and easily accessible to at all risk.

15. Encounter with Candida

Yeast - like opportunistic fungal infection has been reported globally among HIV/AIDS patients, particularly as the etiologic agent of oral thrush. Fluconazoleantifungal has been most popularly employed in treating cases of oral thrush in HIV/AIDS patients. Recentreports have recorded antifungal drug resistance among immunocompromised subjects. This constitutes a big problem in the management of opportunistic candidiasis. Also the NCCLS micro/macrodilution sensitivity testing procedure is expensive, cumbersone and requires a level of sophistication. We, therefore, carried out a study to compare NCCLS M-27-A macrodilution method (expensive) with agar diffusion technique (cheap and simple), to provide a reliable rapid alternative to the new

pressing need for antifungal routine sensitivity testing (Enwuru *et. al.*,2007).

Our findings made us to conclude that broncho-oro-pharyngeal Candida and other yeast-like species existed in about one third of the HIV/AIDS patients studied, in which *Candida albicans* was the most prevalent, while about 10% of all the Candida isolates were resistant to fluconazole. The reliability of germtube production as a confirmatory test for *Candida albicans* in HIV infection was as high as 96.7% and is, therefore, recommended for continued use. Agar diffusion compared favourably with the NCCLS macrodilution technique, hence it is recommended for routine antifungal sensitivity test on all isolates of yeast-like cells from HJV/AIDS subjects.Also, Enwuru *et al.* (2008) reported existence of 9.5% fluconazole resistant strains of oro-pharyngeal yeast-like cells among HIV/AIDS patients and, therefore, highlighted the need for routine antifungal susceptibility testing on HIV patients with cases of initial or repeat episodes of oro-pharyngeal candidiasis (OPC).

16. Encounter with *Malassezia* species.

Malassezia species are mycoflora of human skin with colonization as early as the neonatal period. However, they are often associated with superficial skin infection known as pityriasis versicolor (PV) or tinea versicolor with little reports on their involvement in systemic diseases in developing nations. Recent rise in cases of morbidity and mortality due to fungal sepsis among children in various countries warrants us to determine the occurrence of Malassezia fungemia with cases of PV and bacteremia among pupils attending public primary schools in Ogun State, Nigeria. (Effedua *et al*, 2009). Our findings show that symptomatic pityriaris versicolor (PV) is both a superficial and systemic mycosis and could occur as a co-infection with bacteremia in pupils. We recommend that these findings should be considered in the

management of this mycotic infection of the skin.

17. Encounter with *Listeria* species

Listeria monocytogenes and other *Listeria* species, as bacterial opportunistic infectious agents in HIV/AIDS patients, are rarely studied prospectively, particularly in developing nations of the world. Furthermore, antibiotic susceptibility data of *Listeria* are scarce, and from the initial observation of *Listeria* as being generally antibiotic susceptible, its resistance to antibiotic agents has gradually evolved over the years. The incidence and antimicrobial resistance profile of *Listeria monocytogenes* and other *Listeria* species in HIV/AIDS patients in Lagos, Nigeria were, therefore, investigated (Akano *et al.*,2014). Fecal samples from 326 HIV/AIDS patients and 200 HIV sero-negative gastroenteritis patients (control) at Lagos State University Teaching Hospital, Lagos, Nigeria, were screened for the presence of 6 different species of *Listeria* and the antibiotic resistance profile of the isolates were determined by the disc diffusion method of antibiotic susceptibility test.

We found a statistically significant difference in the incidence of *Listeria monocytogenes* (8.9%) and *Listeria* species (23.3%) in HIV/AIDS patients compared with the incidence of (1%) and (5.5%) respectively in HIV sero-negative patients (control). These findings agree with previous ones which have identified immune-suppressive status in HIV/AIDS patients as a risk factor of the disease, listeriosis. The antimicrobial resistance profile of the isolates revealed marked resistance to antibioticstested in varying degrees. The implication of this in deciding the drug of choice for the treatment of the disease, listeriosis, and also the status of *Listeria monocytogenes* as a vector candidate in HIV/AIDS vaccine research, in view of the emerging resistance of the organism to antibiotics, were discussed.

18. Encounter with viral infection of human respiratory tract

Wide ranges of viruses are known to be associated with respiratory diseases in humans.

Occurrence of different viruses in acute respiratory tract infections of Nigerian children was,therefore, examined (Akinloye *et al.* 2011). Respiratory swabs were collected from 246 children referred to hospital clinics because of acute respiratory symptoms from February through May 2009.

Validated real-time RT-PCR techniques revealed nucleic acids of at least one virus group in 189 specimens (77%). Human rhinoviruses and parainfluenza viruses were present each in one third of the children. Adenoviruses, humanmetapneumovirus, human bocavirus, and influenza C virus were also relatively common. Possibly due to their seasonal occurrence,influenza A and B viruses, and respiratory syncytial virus were detected rarely.We conclude that all major groups of respiratory tractviruses are causing illness in Nigerian children (Akinloye *et al.*,2011).

19. Encounter with antimicrobial resistant bacteria

The increasing use of antimicrobial agents has been reported to provide a strong selective force favouring the survival of those bacterial strains that have acquired resistance to such agents. *Klebsiella pneumoniae*and *Escherichia coli* are two of such notorious enteric bacilli because of their occurrences as nosocomial and a community acquired pathogens (Ogunledun*et al.*, 2000). *E. coli* has also been implicated in asymptomatic infections and carriage by food animals in Nigeria (Adenipekun *et al*, 2015). Antimicrobial profiles demonstrated that all the isolates from out-patients were resistant to ampicillin while most of them exhibited multiple resistances to cefuroxime, nalidixic acid, nitrofurantoin, tetracycline, co-trimoxazole and streptomycin (Ogunledun*et al*; 2000). We concluded that further studies to determine the

molecular basis of the multiple antibiotic resistance would be beneficial.

Foodborne bacteria are often associated with human infections. These infections can become more complicated to treat if the bacteria are also resistant to antimicrobials. We determined the prevalence, antimicrobial resistance, and genetic relatedness of *Escherichia coli* among food producing animals from Lagos, Nigeria from December 2012 to June 2013.*E. coli* were isolated from fecal samples of healthy cattle, chicken, and swine. Antimicrobial susceptibility testing against 22 antimicrobials was performed using broth microdilution with the Sensititre_ system. Clonal types were determined by pulsed-field gel electrophoresis (PFGE). (Adenipekun *et al*, 2015).From the analysis, 211/238 (88.7%), 170/210 (81%), and 136/152 (89.5%) samples from cattle, chicken, and swine, respectively, were positive for *E. coli*. A subset of those isolates (n = 211) selected based on beta-lactamase production was chosen for further study.

Overall, *E. coli* exhibited the highest resistance to tetracycline (124/211; 58.8%), trimethoprim/sulfamethoxazole (84/211; 39.8%), and ampicillin (72/211; 34.1%). Approximately 40% of the isolates were pan-susceptible, and none of the isolates were resistant to amikacin, cefepime, ceftazidime, ertapenem, meropenem, or tigecycline. Among the resistant isolates, 28 different resistance patterns were observed; 26 of those were characterized as multi-drug resistant. One isolate was resistant to 13 different antimicrobials representing five different antimicrobial classes. Using PFGE, MDR *E. coli* were genetically diverse and overall were not group-based on source. Identical PFGE patterns were detected among isolates from different sources. These results suggest that isolates cannot be attributed to specific sources, as some may be present across all of the sources. Results from this study indicate that food-producing animals in Nigeria are a reservoir of MDR *E. coli* that may be transferred to humans via the food chain (Adenipekun *et al.*, 2015)

20. Encounter with plasmid as a disseminator of bacteria antibiotic resistance

The use of molecular microbiology diagnostic approach as a countermeasure against bacterial resistance to antibiotics requires modern and expensive thermocycler machines, which are only available at special research centres such as the Nigerian Institute of Medical Research (NIMR), Yaba and at few privileged Nigerian tertiary institutions. This situation warranted me to enter into research collaboration with Dr. B.A. Iwalokun who is the current Head of Molecular & Biotechnology Division at NIMR in my subsequent research encounter with multi-drug resistant (MDR) bacteria. I also entered into collaboration with Dr. Charlene Jackson, a Lead Scientist and Molecular Microbiologist at the USDA.

Plasmids are extra-chromosomal genetic elements present in some Gram-negative bacteria. They specify a wide range of biological functions that induce in the bacteria, resistance to antibiotics, production of enterotoxin and the ability to transmit themselves by various mechanisms. In many parts of the world, plasmid profile analysis has been used as an epidemiological tool in investigating outbreaks of infectious diseases. Plasmid profile analysis may aid in the identification of a source of infection, differentiating strains or evaluating of the efficiency of control measures. In one of our studies, we screened 650 patients attending the out-patients clinics of the Ogun State University Teaching Hospital for presence of antibiotic resistant and R-plasmid carrying *Escherichia coli* in their urine (Dainiet *al.* (1998). The prevalence of this organism was 47.2% while 20.0% of the isolates harboured plasmid ranging in sizes from 2.2 to 18.0kb. The rate (80%) of streptomycin resistance in plasmid carrying *E.coli* was significantly higher than the rate (40%) in non-plasmid carrying strains ($X^2<0.05$). No significant association was found in other antibiotics.

We concluded that streptomycin resistant genes of *E. coli* appeared to be plasmid-borne. R-plasmids of some Gram negative enteric

bacilli have also been associated with bacterial resistance to quinolones resistance (Daini *et al.*, 2006).

Further attempts were made to characterize and determine the rate of transmission of R-plasmids of *Shigella* isolates from Lagos by using well established plasmid extraction techniques and plasmid curing methods while gene transfer experiments were achieved by using conjugation and transformation techniques. Our findings revealed high transfer rate of multidrug resistance (MDR) among Shigella isolates in Lagos (Iwalokun *et al*; 2002b). This could further complicate the therapeutic management of infectious diseases caused by bacteria as Shigella could transfer MDR genes to other pathogenic bacteria in the crowded Lagos City through its harboured plasmids.

21. Encounter with Beta-Lactamase as virulence factors of antibiotic resistant bacteria

Bacterial infections associated with multidrug resistance have been implicated in the high mortality and morbidity among cancer patients. In recent years, Gramnegative bacterial isolates from patients with neoplasia have been found to produce beta-lactamases and this is of interest in developing country where it is unreported or underreported. We, therefore, carried out a study to determine beta-lactamase mediated resistance in Gram negative bacterial isolate from patients attending the Radiology and Oncology Clinic of Lagos University Teaching Hospital between April and November in 2006 (Adenipekun *et al.,* 2009). Our result findings revealed a high occurrence of beta-lactamase mediated resistance among clinical bacterial isolates from cancer patients. Many of these isolates harbored plasmids which may encode genes for antibiotic resistance of bacteria as virulence factors which are becoming persistent problems in the healthcare sector.Some of them produce beta-lactamase enzymes. Beta-lactamase enzymes production in Gram-negative bacteria remains a formidable threat to therapeutic interventions and impact negatively on the course and outcome of

infections in patients worldwide (Enwuru *et al.,* 2013).

22. Encounter with microbes, antiseptics and disinfectants

Antiseptics and disinfectants are chemical compounds commonly added to water for use during bath, laundry, mouth washing, wound dressing and other domestic activities such as toilet and general house cleaning. They are used to control or reduce the growth of pathogenic microbes found on human body. Many antiseptics in Nigeria markets today have varying degrees of effectiveness. We found Carex powerful antiseptic liquid, produced by PZ Cussons Nigeria PLC to possess both antibacterial and antifungal activity, (Ogunledun *et al*, 2008). These variations may be attributable to their active ingredients. Most of the previously reported studies have been on the effects of these chemical agents on bacteria. There is paucity of reports on the effects of antiseptics on yeast- like organisms such as Candida species, which though are normal flora of human body but can become opportunistic pathogens when human immunity is compromised.

The efficacy of chlorinated and non- chlorinated antiseptics on *Candida albicans* was not completely elucidated. Hence we determined the anti-candidal efficacy of nine commonly available antiseptics with chlorine namely: Purit, Savlon, Robert, Septol, Xylol and Dettol and three without chlorine namely: Spring Mint, TCP and A.M.P.M (Atayese *et al*, 2010). The organism was challenged with diluted (according to the instruction of the manufacturers) of each of the antiseptics for a period between 30 seconds and 180 seconds and the microbial cell reduction rates were determined at every 30seconds contact by Time kill Test. The undiluted antiseptics with chlorine gave 100% reduction in *C. albicans* cell count at 60secs contact time for Purit and Savlon while at 90secs undiluted Robert, Septol, Xylol and Dettol produced the same 100% lethal effect. Spring Mint, TCP and A.M.P.M. without chlorine did not produce significant cell

reduction even at 180secs just like the control. Purit and Savlon, diluted according to the manufacturer's recommendations produced 100% cell reduction at 120 and 150secs respectively while Robert, Septol, Xylol and Dettol were able to produce 93.8% and 96.1% cell reduction at 180secs. Also, the pH of the antiseptics had significant association with their efficacy on *Candida albicans* ($\chi 2=3.54$, $P < 0.05$). It is concluded that chlorination and pH of antiseptics have significant effect on the efficacy of antiseptics against *C. albicans (Atayese et al., 2010)*.

The increasing prevalence of *Pseudomonas aeruginosa* in wound infections have been a major concern. Antiseptics are developed to inhibit or reduce the number of bacteria in or on living tissues. Several antiseptics are available in the market with paucity of information on their efficacy. We, therefore, determined the efficacies of some liquid antiseptics against *P. aeruginosa* isolated from wounds using both qualitative and quantitative methods (Deji-Agbboola *et al.*,2012). The result of the purity test showed that all the antiseptics were sterile prior to use. The comparative assessment of the zones of inhibition of the diluted antiseptics indicated that Ethanol, TCP and Methylated Spirit were least effective ($F = 799.94$, $p<0.05$). Savlon produced the largest zone of inhibition followed by Purit. The result of the quantitative test using the MBC/MIC ratio showed that 8 (66.7%) were bactericidal with MBC/MIC ratio < 4. The presence of organic matter (plasma) in the undiluted and diluted antiseptics was observed to significantly ($t = 11.48$, $P<0.05$) reduce their zones of inhibition when compared with those without plasma. We concluded that antiseptics tested are potent against *P. aeruginosa*; their efficacy are reduced in the presence of organic matters.

23. Search for natural products against microbial infections

23.1. Clinical trial conducted on To-To Ointment and Soap Products

The traditional practices of topically treating dermatological conditions with plant-derived medicines predate the culture of ancient Egypt and remain vital today in the industrialized cultures of both the United State and Europe (Brown & Dattner, 1998). Recent scientific study lend support to some of the claims of herbal practitioners for the safety efficacy of many herbal remedies (Brown & Dattner, 1998: Koo &Arain, 1998). To-To ointment and soap are such products (Table 7),produced from herbs that have acclaimed medicinal value. The products were evaluated for registration with the National Agency of Food and Drug Administration and Control (NAFDAC). To-To was described by manufacturer as purely of indigenous (Nigerian) origin and effective against common skin diseases such as fungal and bacterial infections, scabies, acne, vulgaris (pimples) and dandruff.

This claim suggests a broad spectrum of antimicrobial activity, but to the best of our knowledge, no report on the clinical efficacy of the product was available. We, therefore, carried out a study to evaluate the efficacy and tolerability of To-To ointment and soap in the management of common skin disorders at the Olabisi Onabanjo University Teaching Hospital (OOUTH) Sagamu and throughout the surrounding community. We found To- To ointment and soap to be particularly efficacious in the management of common skin conditions such as fungal and bacterial skin infections, scabies, acne vulgaris and dandruff (Alebiosu *et al., 2003)*.

Table 7: Components of To-To Ointment and To-To Soap

S/No	Components	
	To-To Ointment	To-To Soap
1.	Paraben	Elaeis guineesis
2.	Elaeis guineesis	Butyrospermum paradoxum oils
3.	Butyrospermum paradoxum oils	Sodium hydroxide BP
4.	Paraffin 80 %	Titanium dioxide BP
5.	Titanium dioxide BP	Halogenated phenol BP
6.	Sulphur BP	H_2O
7.	H_2O 6%	Fragrance
8.	Fragrance	

Source: Alebiosu *et al.* (2003)

23.2 *Aloe vera* as Anti - dermatophyte Agent

Dermatophytes are keratinophylic fungi that cause various skin diseases known as dermatophytoses (ringworms) in humans. In order to predict the ability of a given antimycotic agent to eradicate the fungi isolate, in vitro susceptibility testing becomes helpful.We, therefore, carried out a study to determine the susceptibility of clinical isolates of dermatophytesto *Aloe vera* juices using agar diffusion and broth dilution techniques (Oladejo *et al.*,2013). Comparative mean zones of inhibition of *Aloe vera* juices against the dermatophytes clinical isolates using agar disc and well diffusion methods showed no significant difference in the two cultural methods for determining antifungal activities of *Aloe vera* juices against dermatophytes ($P>0.05$). Also, no discrepancy was obtained between the results of Minimum Inhibitory Dilutions (MID) and Minimum Fungicidal Dilutions (MFD) of *Aloe vera* juices against *Epidermophyton floccosum* using macro broth dilution methods.

The results of our study show that both agar diffusion and broth dilution in-vitro techniques can be used to determine susceptibility

of dermatophytes to antifungal juices of *Aloe vera (Oladejoet al.,2013).*

23.3 *Aloe vera* as Anti- bacteria Agent.

Rapid increasing emergence of antibiotic resistant bacterial strains is a growing problem and a threat to public health both in developed and developing nations of the world. Therefore, we determined the antimicrobial efficacy of *Aloe vera* against multi- drug resistant bacteria isolates causing various bacteria infections (Akinduti *et al.*,2013). The *Aloe vera* juice of 30uL/disc was prepared from a household garden in Abeokuta, Nigeria and commonly used antibiotic discs were tested against bacteria isolates by agar disc diffusion method. The clinical isolates tested include *Escherichia coli, Klebsiella oxytoca* and *Citrobacter* spp. All the isolates showed 100% resistance to ceftriazone and nitrofurantoin while 76.7% were susceptible to *Aloe vera* juice (Akinduti *et al,* 2013).

23.4 Nutrient Composition of Cocoa-based beverages

Ground cocoa-based beverages are very common food drinks in Nigeria (Daini *et al.*, 2003). They are used as refreshment food drinks and sometimes may be taken as substitute for water (Dada *et al.*, 1982). Cocoa-based beverages are used as dietary supplement to enrich the food of either a sick person or a woman just delivered of a baby to either replenish the lost energy, essential minerals and vitamins or vitality, while some just consume it as a refreshment supplement (Dada *et al.*, 1982; Daini *et al.*, 2003).

However, the nutrient composition of cocoa-based beverages (CBBs) in sachet polythene bags (*eruku Oshodi*), produced by local small scale companies (SSCs) have received least attention despite their phenomenal increase in production and packaging since the structural adjustment programme of 1985 in Nigeria. This situation warranted Ogunledun (2007) to carry out a comparative study on mineral and vitamin contents of "*eruku Oshodi*", which are produced by SSCs and Milo and Bournvita, which are produced by the multinational companies (MCs). It was discovered that both the mean values of four(4) minerals and five(5) vitamins of "*eruku Oshodi*" were significantly lower than those of the multinational CBBs (Milo and Bournvita) ($P<0.05$) as shown in tables 8, 9 and 10.

The results made Ogunledun (2007) to recommend minerals and vitamins fortification of the cocoa-based beverages provided by the small scale companies so that they can meet the regulatory standards for human consumption.

Table 8. Comparison of Mineral contents (mg/100g) of CBBs by MCs and SSCs.

Mineral Contents	Source	Mean	SD	N	t-values	P value
Magnesium	MCs	540	282.8	2	12.69	<0.01
	SSCs	138.2	16.2	48		
Phosphorus	MCs	875	21.2	2	16.39	<0.01
	SSCs	152.2	61.7	48		
Iron	MCs	12.5	0.7	2	26.44	<0.01

MCs= Multinational Companies SD= Standard Deviation
SSCs = Small Scale Companies
Source: Ogunledun, (2007).

Table 9. Comparison of Vitamin A and D (mg/100g) of CBBs by MCs and SSCs

Vitamin	Source	Mean	SD	N	t-values	P value
A	MCs	6680.5	55.9	2	591.49	<0.01
	SSCs	493.3	12.2	48		
D	MCs	785	374.8	2	17.73	<0.01
	SSCs	91.9	2.9	48		

MCs= Multinational Companies SD= Standard Deviation
SSCs = Small Scale Companies
Source: Ogunledun, (2007).

Table 10. Comparison of Vitamin B (mg/100g) of CBBs by MCs and SSCs

Vitamin	Source	Mean	SD	N	t-values	P value
B1	MCs	2.0	0.2	2	71.45	<0.01
	SSCs	0.1	0.0	48		
B2	MCs	2.0	0.3	2	41.22	<0.01
	SSCs	0.2	0.0	48		
B3	MCs	27.1	5.5	2	0.8	<0.01
	SSCs	26.1	1.6	48		
B5	MCs	13.5	2.1	2	35.14	<0.01
	SSCs	3.4	0.3	48		
B6	MCs	3.1	0.1	2	0.63	<0.01
	SSCs	3.2	0.4	48		

MCs= Multinational Companies SD= Standard Deviation SSCs = Small Scale Companies
Source: Ogunledun, (2007).

23.5 Cocoa Powder as Anti-malaria Agent

Malaria is one of the most deadly parasitic diseases in the world killing more than one million people annually. It is a public health problem because many of the drugs that are being prescribed for the treatment of malaria have become ineffective to the disease. We, therefore, determined the anti-malaria activity of cocoa powder through the use of mouse model(Jayeola *et al.,* 2011). Natural cocoa powder was used to compound mice feed and this was both pre-fed and post-fed to mice that had been infected with *Plasmodium berghei.*

The results indicated that cocoa powder had both therapeutic and prophylactic effects against *P. berghei.* The mean percentage plasmodial reduction expressed in mice post-fed with cocoa and those treated with chloroquine were 60.82 ± 8.47% and 60.09 ± 7.84% respectively. This is an indication that both agents exhibited plasmodial reduction almost at equal frequency. Though,

percentage *plasmodium* reduction was more in mice pre-fed with cocoa than those post-fed with cocoa, but the difference was not significant ($P > 0.05$). The observationof higher percentage of plasmodial reduction in mice pre-fed with cocoa suggested it may possess an immune-booster effect, which action is anti-malarial (Jayeola *et al.*, 2011).

Drug resistance in malaria warrants the need for alternative therapy from plant food nutrients. The search for novel anti-malarial control spurred a great interest in cocoa which has been portrayed as immune booster against malaria(**Jayeola *et al.*, 2011**). We, therefore, estimated CD4+ cells of *P. berghei* infected mice treated with cocoa powder extract (CPE) to provide substantive scientific evidence to authenticate the anecdotal report (Aladesemipe *et al.*, 2013). Brine shrimp toxicity assay was done to determine LC50 of crude cocoa powder extract. The mice were infected with 1×10^7 of ANKA and NK65 strains of *Plasmodium berghei* intraperitoneally, while graded doses of the extract were administered by an intra-gastric intubation based on the body weight of mice. Blood samples were analyzed for microscopy and flow cytometry for CD4+ cell counts.

The onset of infection was delayed in the group treated before inoculations on day 3 and the level of *P. berghei* parasitemia was positively associated with induction of CD4+ cells while the negative control group that received normal saline had progressive increase of parasitemia. The mean survival time could not go beyond day14 in ANKA, though both strains responded to CPE in a similar way with chloroquine as a positive control. The CD4+ cells counted increased in both strains treated before and during inoculations and the episodes of malaria was suppressed compared with the control.
This study has demonstrated that the antiplasmodial activity of CPE was associated with the level of CD4+ T-cells proliferation which initiated the protective immune response. This, therefore,calls for efforts to ensure adequate intake of cocoa powder to boost immunity against malaria (Aladesemipe*et al.*, 2013).

23.6 Probiotics in yoghurts

Yogurts are ready to drink foods commonly taken for energy production and for health in Nigeria but there is paucity of studies done to evaluate their food safety. Therefore, we carried out a study to determine the microflora of some available yogurts sold in Ibadan (Alli *et al.*,2010). A total of 25 different organisms were isolated from 20 yogurt samples with *Lactobacillus bulgaricus, Streptococcus lactis and Saccharomyces cerevisiae* each being the most frequently isolated with frequency of 16.0%. They were also tested to show if their pH production was lactosedependent. Our study has shown that most yogurts in Ibadan contain probiotics isolates including *L. bulgaricus, S.lactis* and *S. cerevisiae*, which are beneficial for human consumption.
Yogurt and starter culture producers are still searching for strains of *Lactobacillus acidophilus* toproduce healthier yogurt with a longer shelf life and better texture, taste, and quality. Our study determined the genotyping of bacteriocin producing *Lactobacillus acidophilus* strains recovered from Nigerian yogurts (Alli *et al.*,2015) .Yogurt samples were collected from four different States of South West regions of Nigeria. Isolates were obtained from MRS Medium and biochemically characterized. This was further confirmed by API50CH. The bacteriocin positivity and activity were determined. Genomic characterization of the*Lactobacillus acidophilus* strains was done with randomly amplified polymorphic (RAP) DNA-PCR.

All yogurt samples containing *Lactobacillus acidophilus* strains met the probiotic requirement of $\geq 10^6$ cfu/mL. The gel picture revealed 6 RAPD clonal types of *Lactobacillus acidophilus* strains with RAPD type C observed to be more common. Significant

differences existed in the mean growth inhibition zones for *E. coli* clinical isolates,*Enterobacter* sp, *Salmonellatyphi* and *Staphylococcus aureus* ($P < 0.05$). There was no correlation between the bacteriocin production, activity, and their RAPD clonal division ($P = 0.1610$). We concluded that *L. acidophilus* isolated in Nigerian yogurt samples met the probiotic requirements of $\geq 10^6$ cfu/ml and produce bacteriocins with good spectrum of activity.

23.7 Honey as antimicrobial agent

Resistance of pathogenic microorganisms to antibiotics is a serious global health concern. A research review investigating the antimicrobial properties of honeys from around the world against skin relevant microbes was carried out by McLoone *et al,* (2015). A plethora of *in-vitro* studies revealed that honeys from all over the world have potent antimicrobial activity against dermatologically important microbes. Moreover, *in-vitro* studies have shown that honey can reduce microbial pathogenicity as well as reverse antimicrobial resistance. Studies investigating the antimicrobial properties of honey *in-vivo* have been more controversial. It is evident that innovative research is required to exploit the antimicrobial properties of honey for clinical use and to determine the efficacy of honey in the treatment of a range of skin disorders with a microbial etiology.

24. Way Forward

24.1. Reconciliation between human and microbes

Peace in any encounter between individuals or nations can easily be achieved through dialogue and reconciliation. But how can humans achieve reconciliation with microbes that cannot talk? Man must regard microbes as handworks of the Almighty God, which are created for the benefit of mankind. Only very few of the microbes are pathogenic to man when they find themselves in various parts of the body where they are not supposed to be. These few pathogenic

microbes develop virulent factors such as capsule, pili(fimbriae), endospores and may also produce lytic enzymes and toxins in order to overcome the products of human immune system and to survive inthe human body where they are not created to be. Those microbes, which are naturally found in human body, are there to fight unwanted microbes coming in through air, water, food and contact with bed spreads contaminated with pathogenic microbes.

It is, therefore, very important that man must avoid the abused use of antibiotics that makes microbes to develop resistance to the synthetic antibiotics. Also, man must adhere to simple personal hygiene in order to avoid contact with disease causing microbes. Simple hand washing with soap after using toilet, covering mouth with handkerchief when coughing, regular cutting of bushes and proper disposal of empty cans around us and drainage, avoiding human contact with insects, which are vectors of microbial agents are some of the most common simple ways by which man can abate the spread of infectious diseases caused by microbes. Man has to change his careless attitudes from polluting his environment to keeping his environment very neat.

How the microbes, which are mostly unicellular, devoid of tissues, organs (such as brain to think) and also devoid of systems, are able to cause diseases which may lead to the death of multi-cellular, multi-tissue, multi-organ and multi-system man with a very robust brain is only known to the Creator of Heaven and Earth and the Creator of living and non-living things. Man must begin to realize that there are certain things such as air, water and soil which were created by the Almighty God for the benefit of man. For instance, no man has seen air and yet we believe in its existence that God created air for man's benefit. Since no man knows where the air is coming from and where it is going, no man can get rid of air on this earth. Man should have the same belief that he can never win encounter with microbes.

24.2. Microbes as therapeutic agents for cancer and microbial infections

Microbes are now being considered to offer a promising means for preventing and treating microbial infections and cancers both of which can become resistant to conventional treatments. Despite great efforts, these diseases remain difficult and sometimes become impossible to treat, suggesting that unconventional strategies will be required to meet these challenges. Therapeutic bacteria and viruses including phages have been reported to offer potential advantages over traditional pharmaceutical products in laboratory animals (Thamm *et al*., 2005;Adhya *et al.,* 2014;Weiman,2014).

Suitable microbes with multiple targeting and cytotoxic mechanisms have been postulated to be more difficult for tumors to evade than are conventional drugs (Weiman,2014). Unlike conventional drugs, microbes are believed capable of counter-evolving to avoid resistance and maintain their long-term efficacy. In many cases, therapeutic microbes are expected to replicate within the patient who is being treated at the site where that treatment is needed, effectively establishing the dose that is needed to the level of disease encountered, while sparing patients many unwanted side effects.

Weiman (2014) also highlighted immune-stimulatory properties of therapeutic microbes as powerful strategy of recruiting a system within patients that is designed to combat their diseases. It is believed, that therapeutic microbes can help in eliminating primary tumors, while stimulating adaptive responses to prevent metastases and relapse. If therapeutic microbes can block or eliminate these aggressive manifestations of cancer while they are still at the microscopic stage and thus undetectable by other means, this approach would be a true breakthrough in cancer treatment. However, these experimental therapeutic microbial agents still face significant hurdles before they can be considered fully ready to treat those diseases in humans. Genetic manipulation will be needed to provide powerful ways to improve the targeting, efficacy and safety

of therapeutic microbes now being developed.

24.3: Plants for medicinal purpose

Plants were made by the Almighty God for human uses (Genesis 1: 29). I quote: "And God said behold I have given every herb bearing seed, which is upon the face of the earth, and every tree, in which is the fruit of a tree yielding seed to you it shall be for meal." This implies that man has to find his way back to the garden of Eden in order to counter the challenges of drug resistance. But this time around, man must remain obedient to all the commandments of the Almighty God so that man does not fall a second time.

Plants are useful to man for food, nutrition, medicine, shelter and for many other purposes in human life (Odugbemi, 2006). The Federal Ministry of Health Document (1988) highlighted the importance of the useful aspects of traditional medicine and practices being incorporated to healthcare delivery at primary health care level. The implementation of this noble policy is overdue in Nigeria.

Plants are rich in a wide variety of secondary metabolites such as tannins, terpenoids, alkaloids and flavonoids, which have been found *in vitro* to have antimicrobial properties. Medicinal plants will provide an alternative source of treatment of diseases in developing nations, since most of the inhabitants cannot afford to pay hospital bills. However, more scientific investigations have to be done on the toxicity of the extracts of these plants on human tissues, organs and systems before making use of them as alternative remedies in curing microbial infectious diseases in man.

Our university curricula have to undergo a paradigm shift towards training of young scientists (pharmacognosists, pharmacologists, medicinal chemists, medical microbiologists, molecular biologists, biochemists, physiologists etc) who shall be equipped with appropriate knowledge and modern equipment to carry out cutting edge research works on medicinal plants. Among the highly needed equipment for such research is the Liquid-Chromatography-Mass spectrometer (LC-MS). It is gladdening to know that our university has made giant steps in purchasing High Performance Liquid Chromatography (HPLC), which is very useful in drug development from natural materials and in detecting and quantifying mycotoxins in food commodities.

24.4. Cocoa as medicinal drink

Olubamiwa (2007) highlighted the health benefits of drinking cocoa daily. His report shows that intake of pure cocoa beverages reduces frequency of malaria and also reduces the risk of diabetes. Flavonoids in cocoa have also been reported to retard the life cycle of malaria parasite because cocoa flavonoids boost immune responses and increases CD4+ cell counts that may help ward off malaria parasitaemia (Aladesemipe, 2013). These findings will be of tremendous health benefits to people living with HIV/AIDS since the infection usually leads to decrease in CD4+ cell counts, which in turn promotes opportunistic candidiasis (Lakunle *et al,* 2014).

The antioxidants in pure cocoa powder combat free radicals, which have been linked to diseases like cancer, heart disease and stroke (Olubamiwa, 2007). Cocoa power also arrests breast cancer progression (Olubamiwa, 2007). If we take advantage of all thehealth benefits associated with drinking of pure cocoa, we shall be using the strategy of prevention is better than cure and also be abating avoidable microbial infections and afflictions on man.

24.5. The use of honey as a natural antimicrobial agent.

In traditional medicine, honey has been recognized around the world for its wound and skin healing properties (McLoone *et al.*, 2015). Resistance of pathogenic microorganisms to antibiotics is becoming a global health concern. A plethora of *in-vitro* studies have revealed that honey from all over the world have potent microbicidal activity against dermatologically notorious microbes. Therefore, the use of honey as alternative natural remedy against the development of microbial resistance should be promoted through creation of public awareness and more research attention on elucidating its mode of action as a natural antimicrobial agent for skin disorders and wound healing

24.6: Creating Public Awareness on Microbial Infections

According to Oluwadun and Obono (2013), relatively less attention has been paid to malaria reportage like other microbial infections in

Nigerian Newspapers. They are of the opinion that communication is key to malaria elimination. They opined that timely healthcare information can be very useful in reducing child mortality from infectious diseases. Therefore, it is the duty of the mass media to provide information to the public on prevalent health issues such as malaria and other microbial infections by working in synergy with researchers in the university. **By doing this,the Gown shall be taking to the Town and the University shall increasingly becomingrelevant to the community in which it finds itself and ultimately becomingthe peoples'University.**

24.7. Provision of safe drinking water to the public

Safe water is very important to the good health of people. Sustainable national development cannot be achieved without access to safe drinking water and sanitation (Oluwadun, 2015). Human welfare and economic development generally depends on the use of water. Nigeria is still far from meeting the Millennium Development Goal (MDG) target for safe water and sanitation including other health related goal with over 96 million of its citizens lacking access to improved water supply (NAN, 2014). Now that we are in 2015, which is the MDG target year, this becomes more worrisome, just as a latest report ranks Nigeria among the 10 countries in the world that over 60% of the entire population are without access to safe water.

The United Nations General Assembly has recognized safe drinking water and sanitation as human right. Discharging abattoir effluent into sources of human drinking water has been reported to have public health implication (Akano *et al.*, 2013). A better understanding of public perception on safe drinking water will surely contribute to improvement in water management. Government should provide reliable sources of safe water such as tap water and boreholes and deep wells to the communities and also create more public awareness on safe water through radio and other news media. Constant supply of electricity for community members to pump water from the bore holes and deep wells is also crucial.

24.8. Public Vaccination against microbial infectious diseases

Since it is true that prevention is better than cure, human

vaccination against agents of common infectious diseases will no doubt reduce mortality and morbidity rates in human populations especially in the developing nations like Nigeria where resources are limited.. The scientists in the developing nations should wake up now to take part in the aggressive research on the development of effective and protective vaccines against diseases such as malaria and Ebola. Nigerian researchers in particular should continue to provide more credible evidence towards the integration of proven vaccines such as the pneumococcus conjugate vaccine 13 (PCV13) against pneumonia into the national programme on immunization in the country.

24.9. Team work in health care Delivery System

The health workers should see themselves as team players. Every member of a winning team in health care delivery system is very important just as every part of a body is important because it has a specific role to play in the body.No head can do without the neck to support it. No flowering plant can survive without root. No modern medicine/hospital can survive without diagnostic laboratory. This is because accurate laboratory diagnostics are pillars of quality health care (ASLM, 2012). No modern medical programme in any University can survive without Basic Medical Sciences.

25. Contribution to National Development

I am an active pioneering member of the Mycotoxicology Society of Nigeria (MSN), which started as the Nigeria Mycotoxin Awareness and Study Group (NMASG) and later changed name to Nigeria Mycotoxin Awareness and Study Network (NMASN). The Society, which is Non-Governmental, was inaugurated at a meeting convened by Prof. S.O. Fapohunda held on 19th January, 2006 at Babcock University, Ilishan-Remo. Before then, the stake-holders nation-wide held a conference convened by the Mycotoxin Unit of the NAFDAC Central Laboratory, Oshodi-Lagos under the leadership of Prof. Dora Akunyili of blessed memory. The general objective of MSN is to create awareness to Nigerians on the adverse health effects of mycotoxins to humans and animals when ingested in foods and the national economic effect of mycotoxins in exportability of agricultural food commodities to oversea countries. The specific aims of MSN include:

(a) To promote sustained awareness on mycotoxins among farmers, feedmillers, exporters on regular basis.

(b) To enhance research/capacity building resulting in value addition to food consumption

(c) To provide user-friendly solution to mycotoxins menace in agricultural food commodities.

(d) To get governments and international agencies interested (Fapohunda, 2015).

The MSN being an NGO Society is self-funding till date because it is not receiving any statutory corporate support. The Society needs very expensive equipment including ELISA, HPLC, LC-MS/MS and also needs its own central laboratory for training and capacity building. MSN will like to establish an Institute for Mycotoxicology as Nigeria returns to Agricultural nation.Presently, the society has its own Newsletter and Journal.

26. Contributions to University Development

26.1. Capacity building at OOU

a. Medical Programme

As a pioneering lecturer in Obafemi Awolowo College of Health Sciences since 30 years ago, I have been instrumental to the first accreditation of the medical programme in both the then Ogun State University and Olabisi Onabanjo University. I have been part of the academic staff members that produced whatever number of medical doctors this University has produced todate. I was the Head of a Department in 2002 when this great university was declared in the Nigerian newspapers to have the best medical program. I was on sabbatical in Canaanland when the storm blew and nearly wiped out the enviable name of this university from the list of well-established tertiary institutions in this country in 2009. Today, I am happy for this our highly cherished State University that the **sun has risen again and the glory of the institution has returned.**

b. Postgraduate programme in Medical Microbiology

The role of a university is not limited to training of undergraduates but also extended more to capacity building in terms of running postgraduate programs to produce the highly needed manpower in the area of teaching/research. I took over the leadership of my department with 6 MSc students. The department has witnessed upsurge of post-graduates students in Medical Microbiology both at Masters and Doctoral degree levels. As a member of academic staff in the department, I have supervised a total of 65 postgraduate students while **47** of them have bagged **MSc** degree (OOU) in Medical Microbiology and **4** PhD degrees (OOU) in the same degree.

The PhD awardees that I supervised include:

I. Dr David Olusoga Ogbolu (2010)(Matric No:00/7/504B)

I co-supervised Dr David Olusoga Ogbolu's PhD research work with Prof. O.A. Daini and graduated him in September 2010. He worked on "Molecular mechanism of Quinolone resistance in clinical Gram negative enteric bacteria from south western Nigeria". In his PhD research work, he won an award from British Society for Antimicrobial Chemotherapy (BSAC), UK to complete his PhD research work in department of Immunity & Infection, Medical School, and University of Birmingham, UK. As a result of his brilliant performance while on his PhD research bench at Birmingham University, he won another prestigious and highly competitive post-doctoral fellowship grant, awarded by Royal Society Newton International Fellowship in January 2012 also undertaken at University of Birmingham, UK,

to investigate bacterial resistance to carbapenem, a last resort drug against multiple resistance Gram-negative bacteria. With this post-doctoral award, he detected a novel carbapenemase, the molecular detail of which is up-coming soon. In 2014, Dr. David Olusoga Ogbolu was awarded a 10-year follow on Alumi funding of Royal Society Newton International Fellowship. He has many publications in prestigious journals including Nature Review Microbiology (2014). He is presently a senior lecturer and Acting Head, Department of Biomedical Science, College of Health Sciences, Ladoke Akintola University of Technology, Osogbo Campus.

II. Dr. Olayinka Christiana Jayeola (2013)(Matric No: 06/11/005381)

I supervised the research PhD thesis of Dr. Olayinka Christiana Jayeola and graduated her in March 2013. She worked on "Microbiological quantity assessment and anti-plasmodial activity of some cocoa powder in Nigeria". She has received several fellowship travelling grant awards to Netherlands, Malaysia, South Africa, Israel, Ecuador and Belgium for contributing to Food Safety and Agribusiness. She has also served in both National and international key positions that include:

i. Member of Committee on Cocoa Standards organized by Standard Organisation of Nigeria (2009 till date)
ii. NIFST South West Coordinator (2014 till date)
iii. Cocoa Expert for European Standard Organization (2015)

iv. Key Expert for ACP-EU Project aim to increase the capacity of Standard Organization of Nigeria (SON) and to assist Small and Medium scale Enterprises (SMEs) to add value to agricultural crop (2015). Her core areas of research include new product development, food safety and public health issues. She is presently a research scientist at the End Users Research Department of Cocoa Research Institute of Nigeria (CRIN), Ibadan. She has 28 journal publications and 12 others in proceedings and books.

III. Dr. Oluwabukola Margaret Akinloye (2014)(Matric No: 07/03/006568)

I supervised Dr. Oluwabukola Margaret Akinloye's PhD with Dr. Bamidele A. Iwalokun and Dr (Mrs) Mope A. Deji-Agboola as co-supervisor and graduated her in January 2014. She worked on "bacterial and viral agent in upper respiratory tract infection in Ibadan, Nigeria". In her PhD research work, she won so many research travelling grants including:

i. Travel grant by the European Society for Clinical Virology (2007).

ii. Travel and participation grant awarded by the European Federation of Immunological Societies (EFIS)(2008).

iii. Research grant award for studying "Occurrence and characteristics of viral agents in respiratory tract infection in Nigerian Children by the European Society of Clinical Microbiology & Infectious Diseases (2009)

iv. Wellcome Trust Scholarship, Wellcome Trust Genomic Campus, Hinxton, Cambridge (2010)

v. Travel grant by European Society of Clinical Microbiology and Infectious Diseases (ESCMID)(2011)

Dr. (Mrs.) Oluwabukola Akinloye is today a certified and registered MLT by Canadian Society for Medical Laboratory Sciences (CSMLS) and a specialist in Molecular Diagnostic of infectious diseases certified by Public Health Genomics Unit, NIH and Welfare, Helsinki and Finland.

IV. Dr. Hyacinth Izuka Effedua (2015)(Matric No: 04/03/003650)

I supervised the PhD work of Dr. Hyacinth Izuka Effedua who graduated in April 2015. He worked on "Virulence and Antifungal Susceptibility of *Malassezia* species isolated from pupils in selected areas of South –West Nigeria". Hemade a lot of discovery and the outcome of his research resolved the controversy as to whether pityriasis versicolor is superficial or not. He concluded that this disease could be both superficial and systemic. He also concluded unequivocally that virulence factor of *Malassezia*species, which are the causative agents of pityriasis versicolor include protease, lipase and phospholipase. Furthermore, he discovered that *Hura crepitans*contains chemical compounds and antioxidants with broad spectrum of activity against both *Malassezia*and bacteria that may be implicated in co-infection. He was one of the

post graduate student that made the Olabisi Onabanjo University proud in the first National Universities Commission Research & Development first exhibition in 2004 in Abuja. Dr. Effedua actively participated in the epidemiological research on the incidence of dermatophytoses among primary school pupils in some selected towns in Remo, Ogun State in which Mrs. Remi Raheem developed two fungal media named after ROSE (Raheem, Oluwadun, Sola, Effedua). Dr. Effedua is presently a Lecturer I at Babcock University.

Mr. Vice-Chancellor Sir, it is a matter of joy for me to declare that I have gained a lot from supervising my post graduate research students just as they have gained from me. I have come to realize that a candle can light several other candles without its own illumination diminished. The more a teacher gives out knowledge, the more the teacher becomes more knowledgeable in his/her chosen field.I am still currently supervising the research works of the remaining 14 postgraduate students. Two of these students are about to give their post-field PhD research seminars to members of the university community.

26.2. Research Linkages and Collaborations at Local and International levels

No tertiary institution in the world can be an island on its own when it comes to Research and Development because of the need of expensive and well – equipped ultra-modern laboratories. That is why the National University Commission (NUC) encourages linkages and research collaborations between universities at local and international levels.

26.2.1.Research collaboration with CRIN, Ibadan

Through one of my PhD research students, Dr (Mrs) Christiana Jayeola, I entered into a research collaboration with Prof. Chris Olutayo Alebiosu (a former Consultant Physician in the

Department of Internal Medicine & Psychiatry here in OOU) and with Dr. O. Olubamiwa, a Director at the Cocoa Research Institute of Nigeria, and together we won a research grant from the Competitive Agricultural Research Group Scheme (CARGS), Abuja in 2010. We were to research on the efficacy of pure cocoa powder as an anti-diabetes, anti-hypertension and anti-malaria agent in humans following the research findings of Dr.(Mrs.) Christiana Jayeola and Mrs. Dolapo Aladesemipe(of blessed memory) that cocoa powder showed anti-malaria parasitaemia and also raised the CD 4+ cells counts in mice respectively.

26.2.2.Research collaboration with NIMR,Yaba-Lagos

Molecular Microbiology is a very new course and, therefore, there is paucity of experts actively doing research works in that field in the country. Reason is that most Nigerian universities cannot afford to set up Molecular Microbiology research laboratory because the equipment are very expensive despite that Medical Microbiology is now moving away from Petri-dish and microscope to Thermocycler machine for Polymerase Chain Reaction (PCR) as diagnostic and research tools. The National Institute of Medical Research (NIMR), Yaba is incidentally relatively more equipped with research tools for molecular microbiology than any university in the country. Hence, I entered into research collaboration with Dr Bamidele A. Iwalokun in the field of molecular epidemiology and immunology of shigellosis, malaria, cholera and tuberculosis in Nigeria.

Dr. Iwalokun is among the few molecular biologists in Nigeria who understand the language , which the conventional microbiologists speak. He has won many research grants for various studies which include: (i) Oxidative stress markers and uncomplicated malaria in Nigerian children: role of selenium and erythrocyte gene polymorphism (2004), (ii) Site characterization for malaria research and clinical trials of Takwa Bay, a costal settlement in Lagos (2009) in which he was the Principal Investigator. He is also the co-Investigator in the research grant award to find the risk factors and validated biomarkers of sudden death in adult Nigerians, which is still on going (2014-2015).

Dr. Iwalokun is presently the Head of Molecular Biology and Biotechnology Division of Nigerian Institute of Medical Research (NIMR), Yaba – Lagos. He is also an Adjunct Senior lecturer in the Department of Medical Microbiology and Parasitology here in Olabisi Onabanjo University since 2007. He has been teaching Molecular Biology , Microbial Genetics and Immunology up to postgraduate classes and also supervising the research works of numerous MSc. and Ph.D students . He has received so many travelling grants, honors and awards.

One of the benefits of my collaboration with Dr. Iwalokun is the access of my postgraduate research students to training in the use of molecular diagnostic tools in NIMR. Through such local exposure to molecular techniques at NIMR, my research students have won International Traveling Grants to complete their research works abroad.

26.2.3. Research Collaboration with US-DA Antimicrobial Research Unit, Athens GA

Through one of my PhD students who will soon deliver her post field seminar, Mrs Tayo Adenipekun, I have entered into collaborative research with Dr. Charlene Jackson who is a renowned Molecular Microbiologist at US-DA, Antimicrobial Research Unit in Athens Georgia. Our research focus is to determine the genes responsible for antibiotic resistance in bacterial isolates from food producing animals. Because of the impressive performance of Tayo when she was in her laboratory for more than 6 months in 2013 – 2014, Dr. Charlene Jackson granted another PhD research student of mine, Sam Akano, a free training with free access to use molecular research tools and consumable chemicals. Sam Akano spent 2-3 months this year in Dr. Jackson's laboratory in USA working on molecular characterization of Listeria isolated from abattoir workers and from the stools of their cows. Last month Dr. Charlene Jackson from US sent to my research group 9 strains of ATCC in which 7 are Listeria and 2 are *Staphylococcus aureus* strains to serve as standard strains in our research on bacteria resistance and susceptibility to antimicrobial agents.

26.2.4. Research collaboration with Dr. Pauline McLoone

My research group, mainly consisting of my PhD research students, is also collaborating with Dr. Pauline McLoone, an Immunologist in the Department of Biomedical Science, School of Medicine, Nazarbayev University, Astana, Kazakhstan who sent to me 10 different brands of foreign honeys in which we are comparing their antimicrobial efficacy with those of 14 brands of Nigerian honeys. She, in turn, will be determining the immunological responses in laboratory animal and man to consumption of honeys. I have three journal publications with her (Ogunledun *et al.* (2009), Olugbuyiro *et al.* (2011) and McLoone and Oluwadun (2014) while another one on honey has been submitted.

26.2.5. Research collaboration with the Faculty of Pharmacy of OOU

Back here at Olabisi Onabanjo University, I have requested colleagues with skills outside my field of research expertise to co-supervise some of my PhD research students' works. Presently Dr. L. S. Kasim, who is the Head of Pharmaceutical & Medicinal Chemistry Department, Faculty of Pharmacy, OOU is co-supervising the aspect of isolating and characterizing the compound(s) responsible for the anti-dermatophyte activity of *Aloe vera* plant juice in Mrs. Aderemi Ademola-Raheem's PhD research work. This is a bio-guided research work that can lead to Research &Development product, which can be patented in the near future. Mrs. Remi Ademola-Raheem formulated two media for quick isolation and identification of dermatophytes. The two media are named as:

a. ROSE- Modified dermatophyte test medium and
b. ROSE- Modified Rapid sporulation medium

The R stands for Raheem, which is the name of her husband. The O stands for Oluwadun (her supervisor). The S stands for Sola (the name of the CEO of Smooford International Ltd, makers of To-To health care products that gave us the research grants), and the E stands for Effedua who actively participated in the epidemiological research on dermatophytoses.

Mrs Ademola-Raheem has again developed a simple and reliable method of preserving pure culture of dermatophyte isolates in developing nations, where electricity supply is not reliable. This

method is named after herself and her husband as Raheem Ademola Ramota Remi Dermatophyte Preservative Method (RARR-DPM)

26.2.6 Research Collaboration with Ophthalmology Department of OOU

One of my PhD research students, Mrs. Janet Oladejo, is working on the molecular study of the aetiology of microbial keratitis. She is a member of staff of the University of Ilorin Teaching Hospital, from where she collects the bulk of corneal scrapings from patients in Ilorin queried for microbial keratitis. In order for her to compare her findings in Ilorin, which is in Kwara State with that in Sagamu, Ogun State we enter into collaborative research with Dr. H.A. Ajibode, a Consultant Ophthalmologist and his colleagues in the Department of Surgery here in OlabisiOnabanjo University. The results of such comparative study will not only elucidate the influence of different geographical locations on the aetiology of keratitis but will also give update on the antimicrobial susceptibility and resistance profiles of the microbial isolates involved in corneal keratitis. Her research proposal has indicated that there is enormous problem associated with getting adequate corneal scrapings from patients suffering from corneal keratitis. Therefore, we want to know whether molecular diagnostic technique will offer a better alternative over the conventional cultural method.

26.3 Research Grants attracted to Olabisi Onabanjo University.

It is a very expensive exercise to carry out a meaningful research especially in the fields of Science and Medicine. No individual researcher can afford to purchase the cutting edge equipment needed for the experiments and harvesting of scientific data. This is the reason why I decided to use strategic entrepreneurship to visit industries like Smooford International Ltd, Iperu-Remo and PZ Cussons Plc, Town-Planning, Ilupeju-Lagos to inform them about the Research and Development (R&D) services, which the Department of Medical Microbiology & Parasitology of Olabisi

Onabanjo University can provide them. Incidentally, this strategy works and the industries awarded us research grants. The PZ Industry gave us just a week to determine the antimicrobial efficacy of its new R & D product called Carex Powerful Antiseptic, which the Industry was to register with the NAFDAC. We carried out the study for the company and submitted our report. We found the PZ Carex to possess both antibacterial and antifungal activities and, therefore, recommended it, as indeed, a powerful antiseptic.

However, the department lost the proposed consultancy service which the Industry wanted to offer us because at that time the department was sharing a small and ill-equipped laboratory with other three units of Pathology. I am happy today because the Department of Medical Microbiology & Parasitology of OOU is having not only a laboratory of its own but also a well-equipped one with automated ELISA machine with plate washer, plate reader and printer. **Well done the Ogun State Government, Well done the University Council, Well done the University Management!!!**

The Smoodford International Ltd R & D grant was awarded to me twice. First, to carry out the clinical trial of its health soaps and ointment produced from herbs for registration with the NAFDAC. Second, to determine the in-vitro antimicrobial efficacy of each of its ram materials, which compose the products. All these we did within the stipulated period of time and CEO of To-To products was highly impressed.

The benefits of all these services rendered to the Industries are many. First, we used the opportunity to train our postgraduate students how to carry out clinical trial on pharmaceutical products. Second Smooford International Ltd Iperu-Remo gave my department giant refrigerator, electrical generator, a lot of laboratory glass-wares and also sponsored some members of staff to attend International Training Workshop on Bioethics in Clinical Trial, which I now enjoy teaching postgraduate students. In addition, Olabisi Onabanjo University came first at the State Universities level in the First National Universities Commission (NUC) R & D Exhibition in Abuja in 2004 for the To-To products.

27. Conclusion

In conclusion, Mr. Vice-Chancellor Sir, for many years the roles of microbes as part of the Almighty God's wonderful creative works for human benefits have been neglected or not fully understood by man. This may probably be due to the belief of man that microbes are usually the causes of human death. But this is not true because only a fraction of microbesare pathogenic to man while most microbes are extremely vital for sustaining life on earth. The roles of microbes in the ecosystem range from recycling nutrients in soil and water to symbiotic relationships that provides essential micronutrients such as vitamins to their hosts (animals) and nitrates to leguminous plants. I believe that microbial role in death and disease is due to the fall and the curse of man in the Garden of Eden. The mystery in microbes is that nobody knows what day the microbes were created and what they were originally created for. Were they created as part of the earth on Day 3? Were microbes created as separate entities or part of other organisms? Why are viruses created to belong to both living and non-living things? These are just some of the intriguing questions facing the field of microbiology.

Pathogenic microbes are probably as a deviation from the Almighty God's original plan due to the fall of man. The ability of microbes to adapt to their environment through various genetic mechanisms, such as in the case of antibiotic resistance, is often touted as an example of evolution in action. In addition, microbes are unique from animals, plants and humans in their need for variety to deal with changing environments, which they may not be able to escape. Antibiotic resistance is an example of stress survival. Some mutations potentially enable the bacterium to survive exposure to the various antibiotics, but the resistance results from loss or reduction of pre-existing activities such as enzymatic, regulatory or transport systems. However, some microbes may cause disease not because they are altered in some fashions (through genetic changes) but because they have spread to a location, which allows them to invade an organism they were not created to interact with. The origin of microbial diseases is complex and multifaceted and may be explained by a combination of factors including mutations, mobile genes and man's protective defense mechanisms. The Bible

tells us that microbes such as bacteria and viruses were created by the Lord (Colossians 1: 16).After the fall of man, the Bible (Genesis 3: 18) suggests the post-fall. Viral/bacterial oncolytic activity may have arisen as a phenotypic extension of pre-existing normal viral/bacterial activities due to a change to harsh biological environments.

Fungi are amazing organisms. As a group, they have colonized practically every ecological niche on earth. Originally created for good to degrade dead plants and return minerals to the soil. But at unfavorable environmental conditions, some species of filamentous fungi called moulds are capable of converting their excess amino acids into secondary metabolites known as mycotoxins. Mycotoxins are not normally required for normal growth and reproduction of their producers but are injurious to man and animals when ingested in human foods (cereal, grains) and animal feeds. Some of the bad effects of mycotoxins in man are mental hallucination, cancer formation, growth retardation, infertility and nephrotoxicity. However, many antibiotic drugs including penicillin and cyclosporine are fungal secondary metabolites, which today man uses to combat infectious diseases and malignancies.

Mr. Vice-Chancellor Sir, I have highlighted my research encounter with various microbes in the past 38 years as a researcher (1978 - 2015) and as an academic staff here at Olabisi Onabanjo University in the past 30 years (1985 -2015). Going by the statement "No Victor, No Vanquished" the question is how is this relevant to my encounter with microbes? First because of the fall of man and the consequent curse in the Garden of Eden, man becomes a prey to the microbes. Man begins to research on how to survive the harmful effects of microbial infections through eating of balanced diets and practice of simple hygiene The research activities have led man to make various types of microscopes that use light energy or electrons to produce both magnification and resolution of microbes to turnthe invisible microbes visible to the human naked eyes. Also, man has developed staining reagent techniques, which enable scientists to produce contrast between microbes and their background. Furthermore, man has produced microbiological culture media and also manufactured highly sophisticated and sensitive equipment such as rapid diagnostic kits, chromogenic agar and multi-antibiotic discs to cultivate, identify the microbes

and to determine their susceptibility to various antimicrobial agents, which are industrially produced by man.

On the other hand, microbes are ubiquitous and cosmopolitan in the natural environment of man , which includes water, air and soil. Some of them are even found in and on human body from human birth. These are called commensals, which are usually harmless to man. However, some of them have developed various forms of virulence mechanisms which include: (i) adhesion to the human cells (ii) local proliferation or multiplication (iii) damage to the human tissue through the production of toxins and invasive enzymes for their dissemination, (iv) development of specificity for cell, tissue, organ and system and (v) development of resistance to antimicrobial agents. How these microbes, most of which are unicellular, are able to develop all these survival mechanisms without having a brain is only known to their Creator who is the Almighty Allah/God.

Mr. Vice-Chancellor Sir, permit me to make my simple verdict that in **encounter of man with microbes, there is no victor and there is no vanquished** since man and microbes are created by the Almighty God for different purposes for continuity of life.

28. Acknowledgements

I am grateful to the Almighty God, the Creator of all things in heaven and on earth for making my dreams come true today. I am eternally grateful to my two parents who are now late for their financial supports for my education up to the secondary school level, without which I could not have sponsored myself to attend University of Ife, now Obafemi Awolowo University, Ile-Ife. My encounter as a very indigent medical student at Uni-Ife made me to change from a prestigious but tedious and long MBChB Health Sciences degree programme to a BSc Honours degree programme in Microbiology in 1975. I return all the glory to God Almighty for making it possible for my classmate in the Medical School in Ile-Ife, Prof. S. O. Oguniyi, who bought my hard cover Anatomy text book, and my humble self to be both Professors today.

I do hope my students will learn a lesson from this that life is full of ups and downs but the most important thing is for one to remain focused and have faith in Almighty God who created us for a purpose in life. Every successful person has a painful story. Also every painful story has a successful ending. My experience as an indigent undergraduate student has made me to like to play in loco-parental role to all medical students who now nick name me as a Bread and Butter Lecturer. This probably made the 2004 Pathology/Pharmacology class of medical students of this university to award me the most cherished award in my life as the most Fatherly Lecturer in Obafemi Awolowo College of Health Sciences of Olabisi Onabanjo University at a night award dinner chaired by Sir Prof. Tola Osilesi, who was then the Dean of Faculty of Basic Medical Science and later became the Deputy Vice-Chancellor and one time the Vice-Chancellor of this great University.

I am, indeed, very grateful to the two royal families of my wife. First, her father side: The Ogbodo Sonuga Royal Family of Sagamu that produced the current His Royal Highness Oba Fadesewa (the First) of Simawa Land. Second, I also thank her maternal family, the King Family of Lagos for giving me their beautiful and well-brought up daughter to marry in 1988 and for gracing this important occasion of my life today.

I will like to express my very special gratitudes to my very dear

loving and lovely wife Princess Mrs Adepeju Oluwadun (Nee Sonuga). I know it can be very lonely to be a university lecturer's wife because of the frequent periods I have to be away from home for research, external examination, international training, conferences outside the shore of Nigeria, academic works at home, postgraduate students research supervision and grading of heaps of examination scripts only to submit results in a specified short period of time because of the policy of the university. All these constraints definitely prevent me from spending enough of my private time with you to gaze at your beautiful face. However, life has taught both of us that love does not consist in gazing at each other, but in looking outward together in the same direction. In this regard, I thank you very much for your co-operation in the superb upbringing of our two God given gems: Oreoluwapo and Anuoluwapo who today are graduates in Mass Communication and Public Administration respectively. I think of you and our daughters every waking moment of my life and every breath and every beat of my heart. I just can't stop myself loving you. I thank my daughters for being obedient to my instructions; they are indeed obeying the commandment of the Almighty God.

I also like to thank members of my paternal Ogunledun and my maternal Ogunnaike families who are all here to grace and witness this great occasion of my life. I say thank you to Engineer Asiwaju Abiodun Onafuwa who leads the Ogunledun family including Johnson Ayedun,the children of Chief Olu Oyesanya (a former Diplomat and High Commissioner at the Nigerian High Commission Office in London),who are from the first born of Pa Ogunledun, the children of Pa Adebayo (aka Baba Alagofrom Lagos) who are from the last born of Pa Ogunledun, Oyewole (whom I shared the same womb but does not have the, privilege to know our mother), all my siblings from my dad Ali Balogun, my cousin Mrs. Florence Adeyemi (Mama Doctors) and to all my other paternal brothers , sisters and cousins too numerous to mention. Even though I have obeyed the divine Order to change my surname to Oluwadun, I cannot be definitely separated from you. Your joy shall always be my joy and I will always see myself as one of you.

I also say very big thank you to my maternal uncle Otunba Bayo

Ogunnaike (Aranse-Olu Chemist) who leads my maternal delegate here including Builder J.K.Akinsanya and his siblings, Pharmacist (Mrs.) Olufunmilayo Odusoga, Pastor (Mrs.) Ebun Tayo ,Mr. Adeyemi Olatunji and Kunle Olatunji just to mention few. I will always remember and keep in heart all the love and care you showered on me since the sudden departure to the world beyond of my mum in 1953.

I cannot forget to thank the people who have made a difference in my life. I have worked with these people that stimulated and challenged me. They are the people who taught me the best way to start my academic career. They inculcated in me the attitude of never stop learning in life and that life-long learning should be my keyword for bright future. Consequently, I learn from people at all levels. Also that if I want a bright career in future, I should add regular updates to my skills and knowledge. I have found these people to be my role models because of their beliefs that most of the important things in this world have been accomplished by people who had kept on trying when there seemed to be no hope at all. They said to me that I should always remember that everyone who has sown sparingly will reap sparingly and that everyone who has sown generously will also reap generously. Luck favours the well prepared. The training and counsels received from them have made me to set a goal as high as my imagination will let me carry and then strive for that goal every single day of the year.

Mr. Vice-Chancellor Sir, permit me to mention a few of these people who have positively imparted on my life from the inexhaustible list which includes: Prof. Olu Odeyemi (an Environmental Microbiologist) who supervised my BSc Hons degree Microbiology project at the then University of Ife (1978), Prof. Sunday Fadulu (a Mycologist) who supervised my MSc degree dissertation at Texas Southern University, Houston Texas, USA (1984) and Prof. Obasola Fagade who supervised my PhD thesis (2007) at the University of Ibadan and strongly advised me to regard PhD as an abbreviation for Perseverance, hard work and Determination in addition to its literal meaning, which is Doctor of Philosophy. Other people who have imparted positively in my life include:Prof. Matthew Ojo of blessed memory, who voluntarily retired as a Dean at the University of Ibadan in 1986 to help me establish Medical Microbiology& Parasitology here in OOU and

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I thank all my Professors, classmates and colleagues from Obafemi Awolowo University, Ile-Ife (Great Ife) from College of Health Sciences and Faculty of Science and in particular Department of Microbiology for gracing this occasion that gives me opportunity to re-unite with them.

I am delighted to be honoured with the presence of my colleagues from convenant University, Ota, Ladoke Akintola University of Technology, Oshogbo, University of Ilorin, Teaching Hospital, University of Ibadan, UCH Ibadan, OOUTH Sagamu, LUTH, Idi-Araba, Babcock University and member of Micotoxicology Society of Nigeria (MSN) and Association of Medical Laboratory Sience of Nigeria (AMLSN). The Almighty God shall honour you.

I also recognize and appreciate the presence of my classmates(1962-1966 set)and colleagues at Muslim High School, Sagamu who are present here today. I remember the old good days when we used together to take early morning beans and *gari* through out the week in our boarding house without sleeping and dousing and yet remained very active in the class. Though, at that time less did we know that we are privilege to be taking highly nutritious meal. We pray that the Almighty God grant the soul of the founder of our school, Chief F.O.D Sotubo, to rest in perfect peace for his foresight which has positively influenced our lives.

I thank all members of the teaching and non–teaching staff of Olabisi Onabanjo University, whom together we have been serving the humanity for the past 30years. May the Almighty God continue to be our strength.

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I have worked with all Vice-Chancellors of this great University from inception I am impressed by all of them. I pray that the sacrifice they have made to this University will not go unrewarded.

I thank all the invited distinguished guests and Kabiyesis far and near who have come to honour me today. May the Almighty God honour you and your families.

I thank both the resident Pastor, all Pastors and members of winners Chapel Sagamu for gracing this occasion.

Mr. Vice-Chancellor Sir, the Principal Officers of University, the Royal Highnesses, Distinguished Guests, Members of the Press, Ladies and Gentlemen, I indeed thank you for taking time to grace this important occasion ofmy life. I wish you God's journey mercy back to your destinations. Thank you for listening. Remain blessed.

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