



## Environmental Health And Sanitation As Panacea To Disease Control And Prevention.



**24<sup>th</sup> Public Lecture**

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By **SANITARIAN AGWU**

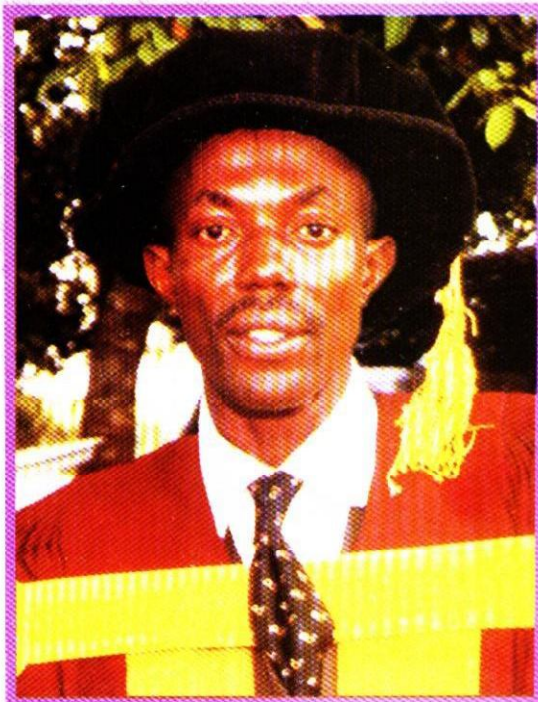
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**24<sup>th</sup> PUBLIC LECTURER**



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Vice Chancellor Sir  
Deputy Vice Chancellor Academics  
Deputy vice chancellor Administration  
Dean and Directors  
Distinguished Professors  
Heads of Departments and Coordinators  
Members of Senates and Congregation  
Great FUTO Students  
Gentlemen of the Press  
Distinguished Ladies and Gentlemen



### **PREAMBLE**

Presenting public lectures in this great institution has become an enviable tradition. It is an honour bestowed on our learned scholars, an opportunity to share their academic, professional and industrial experiences/research in the form of organized lectures within the university community. In a public Lecture, an attempt is usually made to relate the subject area to general community or national needs and goals.

I thank the Vice-Chancellor, Professor Celestine O. E. Onwuliri, and his management team for giving me the opportunity to be the celebrant of this academic and professional harvest. I equally appreciate the teacher of teachers, Chairman of FUTO Public Lecture Series, Emeritus Professor Moses O. E. Iwuala and his Committee for their efforts in making this lecture a reality.

Vice-Chancellor, sir, I am a reader in Public Health Technology and a specialist in Environmental Health and Safety Management, in the Department of Public Health Technology. In the next hour or so, it will be my intention to take us through the world of Environmental Health and Sanitation scenario in Nigeria. I will also x-ray common environmental poisons, their routes of exposure, possible health effects/implications in human population, and strategies for their control and prevention. I hereby crave the indulgence of the audience, as we go through the subject area.

## **INTRODUCTION**

Environmental Health and Sanitation have far-reaching implications on the achievement, or otherwise, of Millennium Development Goals, especially those that relate to environmental sustainability. Achieving these goals in a country like Nigeria requires adequate and skilled professionals that would support and ensure sustainable environmental health and sanitation. As a profession, environmental health is central to the development of the sector.

Globally, nearly one quarter of all deaths and of the total disease burden can be attributed to environmental status. In children, environmental risk factors can account for slightly more than one-third of the disease burden. These findings have important policy implications, as the environmental risk factors can be modified by established, cost-effective interventions. The interventions promote equity by benefiting everyone in the society, while addressing the needs of those most at risk. It is in this regard that the Ministers of Health and Environment in Africa met on 28-29 August 2008 in Libreville, Gabon, and signed the Libreville declaration that identified eleven action points, their related specific activities, resources requirements, stakeholders and timelines. This declaration has resulted in developing a Situation Analysis and Needs Assessment (SANA) in Nigeria, covering environmental risks to human health and ecosystem integrity.

Although it is rich in human and natural resources, Nigeria ranks among the 20 poorest nations globally, with 70 per cent of the population living on less than \$1 a day. Under-five infant and maternal mortality rates have all increased steadily over the two decades. Malaria, ARI, diarrhea, measles, perinatal problems and in recent years, HIV/AIDS, are the major causes of childhood morbidity.

Water and sanitation coverage figures are similar to regional averages, but the rate of change has stagnated in recent years, especially for rural sanitation (which has dropped from 33 per cent in 1990 to 30 per cent in 2002); the scenario has not really changed. Water Environment and Sanitation (WES) sector reforms are being pursued by the government with support from UNICEF and its partners, focusing on strengthening institutions at all three tiers of the government, and the development of

new policies on integrated water resources management and environmental sanitation. Key areas requiring additional attention are sector coordination, monitoring and database systems, water quality control and standards development, and the decentralized delivery of WES services. These actions are to really minimize illness and deaths resulting from poor environmental sanitation.

This lecture provides evidence that health and environmental risks are significant in the cause of human morbidity and mortality. From SANA reports in Africa (Kenya, 2009; Nigeria, 2010), there are increased risks resulting from environmental degradation, e.g., disease vectors from natural factors, drought, floods and drinking water contaminated with organic pollutants both in rural and urban settings. In addition, soil erosion and salinity affect rural and urban settings, respectively. On the other hand, the high risk factors resulting from human activity are the proliferation of disease vectors, drought, floods, drinking water organic pollution, deforestation, marine pollution. Improper wastes management affects the health of both rural and urban dwellers. Furthermore, food contamination due to poor hygiene, indoor and outdoor pollution is adding to the health problems of Nigerians.

### **CONCEPT OF ENVIRONMENT**

The environment is the collective term used to describe all the living and non-living things that make up our surroundings. The environment consists of three major components viz, physical, biological and social or psychosocial environments. The relationship of human beings to their environment is reciprocal in that the environment has a profound influence on them and they, in turn, make extensive alterations to their environment to meet their needs and desires.

#### **Physical Environment**

The physical environment consists of the non-living (abiotic) part of the environment, i.e., air, water, light, heat, radiation, gravity, pressure, climate, soil, house and various chemical agents, inter-alia. The physical environment exerts an indirect effect by determining the distribution of organisms in the biological environment. Humans alter the natural characteristics of the physical environment, sometimes on a small scale,

but often on a very large scale, either by clearing a small patch of bush, building a hut and digging a small canal to irrigate a vegetable garden, to the building of large cities, draining of swamps, irrigating arid zones, damming rivers and creating large artificial lakes. Many of such changes have been beneficial, but some aspects of these changes have created new hazards. On the global scale, there is increasing concern that human activities are steadily leading to a significant rise in the earth's temperature with forecasts of dire results.

### **Biological Environment**

All the living things in an area, i.e., plants, animals and micro-organisms, constitute the biological environment. Humans deliberately manipulate the biological environment by cultivating useful plants to provide food, clothing and shelter and raising farm animals for their meat, milk, leather, wool and other useful products. They hunt and kill wild animals and destroy insects which transmit diseases or which compete with them for food.

### **Social/PSYCHOSOCIAL Environment**

This is the part of the environment that is entirely made by humans. In essence, it represents the situation of human beings as members of society, i.e., family groups, village or urban communities, cultures, including beliefs and attitudes, the organization of society (i.e., politics and government, laws and the judicial system, the educational system, transport and communication; and social services, including health care). Sometimes, we differentiate the economic environment, which includes, all financial institutions, from social environment.

Naturally, several co-players in our environment work assiduously for the maintenance of positive ecological balance whereas man's activity, in his developmental drives, in most cases, results in the degradation and pollution of the environment. In recognition that most of man's activities pose environmental insult and that this situation directly or indirectly constitutes threats to man's life and survival, man learns to take actions that will counter the negative situation. These actions, aimed at restoring the environment to the state where it will ensure continued benefits to man for health and survival, are called environmental sanitation.

## **CONCEPT OF ENVIRONMENTAL HEALTH**

The environment represents a key contributor to human health and diseases. Exposure to substances, such as pollutants, chemicals, allergens and natural toxins, all of which emanate from the environment, can have a detrimental effect on the health of man and animal. Diets and lifestyles can interact with these environmental factors and increase or decrease their effects on health. Some of these environmental factors can be controlled at individual levels, while others need to be controlled at the source through formal public and environmental health decisions.

All diseases generally have complex etiologies that allow for multiple causal and pathogenic factors, including exposure to environmental agents. Scientific and clinical evidence suggests that virtually all human diseases can be caused, modified, or altered by environmental agents. One of the key factors in improving human health is identifying and understanding the basic biological processes that are altered by the environmental factors and that trigger disease processes to begin or alter the course of the disease substantially( Moeller 1999, Lucals and Giles 2003, Amadi 2001, 2002, 2005).

Essentially, environmental health practices are all about creating and maintaining environments that promote good public health within the community. It is about ensuring that basic health requirements, such as clean water, clean air, safe work environment, wholesome food, etc., are available to the citizen. Environmental health has variously been defined as *the control of all factors in man's physical environment, which exercise or may exercise, deleterious effects on his physical development, health or survival* or as comprising those aspects of human health, including quality of life, which is determined by physical, biological, chemical, social and psychological factors in the environment. It refers to the theory and practice of assessing, correcting, controlling, and preventing these factors that can potentially affect adversely the health of present and future generations.

Environmental health is also referred to as those aspects of human health, including quality of life, that are determined by physical, chemical, biological, social and psychosocial factors in the environment. Environmental health programmes should be organized by community

efforts to monitor and modify man-environment relationships in the interest of promoting better health and well-being.

The key components of Environmental health in Nigeria include waste management; food hygiene and control; pest and vector control, environmental health control of housing and sanitation; epidemiological investigation and disease control, air quality management, occupational health and safety, water resources management and sanitation; noise abatement or control; protection of recreational environment; radiation protection and health; health control of frontiers, airports and seaports and border crossings; pollution control and abatement; educational activities (health promotion and education); promotion and enforcement of environmental health quality standards; collaborative efforts to study the effects of environmental hazards (through research); environmental health impact assessment (EHIA) and the management of emergency situations (disasters, flooding, disease outbreaks); etc. (EHORECON, 2007).

More specific components of environmental sanitation are solid waste management, medical waste management, excreta and sewage management, food hygiene and safety, sanitary inspection of premises, market and abattoir sanitation, adequate potable water supply, school sanitation, pest and vector control, management of urban drainage, control of reared and stray animals, disposal of the dead (man and animals), weed and vegetation control and hygiene education and promotion (FMEVN, 2005; EHORECON, 2007).

### **ENVIRONMENTAL SANITATION**

Environmental sanitation is an age-long practice introduced during the early period of human civilization. It started when people began to live together in small village settlements or communities, farming and carrying out their domestic activities with sundry environmental pollution and contamination. *There is evidence of sanitation practices in the Holy Bible. The law of Moses contain some remarkable sanitary codes, ordinances, laws and provisions for Public Health (Leviticus 11-15; Mathew 15:2, Deuteronomy 23: 12-14). In the New International Version of the Holy Bible, God is seen as the Healer of human diseases*

both in natural and supernatural ways (Psalms 103:3; Mathew 8:16-17) and, in certain cases, as the One who sends (that is, allows, as used in the original Hebrew language) diseases or their pathogens (Exodus 9:8; Numbers 21:4-9). Some of the common diseases mentioned/recorded in the Bible are female infertility, blindness, boils, skin disorders/pathologies, food borne infections/diseases or consumption, dropsy, deafness, gastroenteritis or dysentery, epilepsy, fever, inflammations, eczema, leprosy, mental disorders, paralysis or stroke, plaque, scabies, and spots, and demon possession. All these disease conditions are all environmental health and sanitation-borne/based or related diseases and are still endemic in most parts of the globe, including Nigeria.

Sanitation and hygiene are mentioned in so many verses of the Holy Qur'an and the *Hadith* (sayings) of the holy prophet Muhammad, peace be upon him (*pbuh*). Some of them are highlighted below:

#### QUR'AN

1. "Magnify your Lord, *cleanse your garments, and keep away from all pollution*" (chapter 74, verse 4).
2. "They ask you about menstruation. Say: It is an indisposition. Keep aloof from women during their menstrual periods and do not touch them until they are clean again. Then have intercourse with them, as Allah enjoined you. Allah loves those that turn to Him in repentance and purify themselves" (chapter 2, verse 222).
3. "O you who believe! When you intend to offer prayer, wash your faces and your hands (forearms) up to the elbows, rub (by passing wet hands over) your heads, and (wash) your feet up to ankles. If you are in a state of Janaba, purify yourself (bathe your whole body)..." (chapter 5, verse 6).
4. "O ye who believe! Approach not prayers with a mind befogged, until ye can understand all that ye say,- nor in a state of ceremonial impurity (Except when travelling on the road), until

after washing your whole body. If ye are ill, or on a journey, or one of you cometh from offices of nature, or ye have been in contact with women, and ye find no water, then take for yourselves clean sand or earth, and rub therewith your faces and hands. For Allah doth blot out sins and forgive again and again" (chapter 4, verse 43).

5. "O ye who believe! When ye prepare for prayer, *wash your faces, and your hands (and arms) to the elbows; Rub your heads (with water); and (wash) your feet to the ankles.* If ye are in a state of ceremonial impurity, bathe your whole body. But if ye are ill, or on a journey, or one of you cometh from offices of nature, or ye have been in contact with women, and ye find no water, then take for yourselves clean sand or earth, and rub therewith your faces and hands. Allah doth not wish to place you in a difficulty, but to make you clean, and to complete his favour to you, that ye may be grateful" (chapter 5, verse 6).
6. "*Women impure are for men impure, and men impure for women impure and women of purity are for men of purity, and men of purity are for women of purity;* these are not affected by what people say: for them there is forgiveness, and a provision honourable" (chapter 24, verse 26).
7. "Truly, God loves those who turn unto Him in repentance and loves those who purify themselves" (chapter 2, verse 222).

#### HADITH

1. Narrated by Muslim: "*Purity is a half of Eimaan (faith)*"
2. *Islaam is clean, observe cleanliness.* For no one will gain entry into paradise, *except who is clean.*
3. "*The prayer of a person who does hadath (passes, urine, stool or wind) is not accepted until he performs (repeats) the ablution.*" A person from Hadaramout asked Abu Hurairah, "*What is 'hadath'?*" *Abu Hurairah replied, "Hadath' means the passing of wind from the anus."* (Sahih Al-Bukhari, Volume

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1, Book 4, Number 137).

4. A'ishah, the Mother of the Faithful (may Allah be pleased with her) reported: "***The Prophet (peace and blessings be upon him) used his right hand for getting water for ablution and taking food, and his left hand for his evacuation and for anything repugnant***" (Sunan Abu Dawud).
5. Abu Hurairah (may Allah be pleased with him) reported: "***The Messenger of Allah (peace and blessings be upon him) said: 'Be on your guard against two things which provoke cursing'. They (the Companions present there) said: 'Messenger of Allah, what are those things which provoke cursing?' He said, 'Easing on the thoroughfares or under the shades (where people take shelter and rest)'***" (Reported by Muslim).

However, early forms of environmental sanitation were first practiced in the world's famous cities of Europe and Asia in the middle ages, following the outbreak of plague or "Black Death" and other infectious diseases like cholera, typhoid, small pox, etc., which occurred, killing millions as a result of poor sanitation practices. The situation led to increased poverty and untold hardship on the ordinary citizens.

Consequently, the people embarked on environmental sanitation drive to get rid of rubbish dumps and filth in order to check the spate of epidemics, using local materials and methods. These included hand-dug wells for water supply, the channeling of waste water from houses into closed drains, and road sweeping. Besides, the people built their houses with the doors made to open only to the inner yard space and pavement or small walkways for proper ventilation/ illumination. In the Roman cities, for instance, the residents channeled their waste water (*Cloaca maxima*) into the improvised wooden drains, while solid waste was transported to the dump sites with horsed driven carts or trucks. Between the late 16<sup>th</sup> and early 17<sup>th</sup> centuries in London, the residents were also made to sweep the front of their houses in the mornings and evenings.

The environmental sanitation practice in Europe extended to other

countries of the world, which benefited immensely, because of the significant reduction in mortality/morbidity rates and improvements in the quality of life. In Nigeria, sanitation was introduced by British colonial administrators to curb the menace of plague, small pox, yellow fever, cholera, malaria, etc., which were so rampant, especially in 1924. Sewage treatment plants, effective drainage, solid waste management and other sundry sanitary measures were provided for that purpose (Moses, 2006). Until recently, sanitation was not accorded adequate consideration in policy decisions, but today it is among the topical issues of both national and international interest. The reason is not far-fetched, as no nation can attain any meaningful development and prosperity in a dirty and unsustainable environment (FMENV, 2005).

According to the United Nations (2007), sanitation is vital to health; it generates economic benefits and contributes to dignity and social development. The linkages between environment sanitation and development, therefore, cannot be over-emphasized, and this has been noted since the Brundtland Commission's Report in 1987, which revealed the poor state of environmental degradation globally. The development generated a lot of global concern and anxiety among environmental interest groups and the international community at large, thus culminating in the various debates across the world. Notably, the Rio Summit of 1992 in Rio de Janeiro (Brazil), as well as the International Conference in Johannesburg (South Africa) in 2002, on sustainable development cannot be easily forgotten for bringing to limelight issues of the environment and development that impinge directly on human health, one of which is sanitation. This is well articulated in Agenda 21, Vision 2010 and the Millennium Development Goals (MDGs), etc.

Realizing the enormous role environmental sanitation plays in the affairs of , socially and economically, 2008 was declared the International Year of Sanitation (IYS) by the United Nations General Assembly through its Resolution A/C2/61/L.16/Rev.1, dated December 3, 2006. This was done to create awareness on the need for public support and to give impetus to the achievement of the Millennium Development Goals target on sanitation by 2015, for which many countries are not yet on track (WHO/UNICEF/JMP, 2008).

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Furthermore, the World Health Organization (WHO) and its allies, namely, UNICEF and the World Bank, place so much emphasis on sanitation because of the impact on human health and productivity. Also, the World Health Organization (WHO), on its part, is currently championing the promotion of environmental health impact assessment of projects (EHIA) as a way of bringing sanitation practices into the concept of sustainable development. This is necessary when viewed against the background of development activities which turn round to cause adverse effects to the environment and health, instead of progress or prosperity and improvements in the standard of living (WHO, 2005). Communities, countries and governments at all levels throughout the world, therefore, have been called upon to be more committed to the promotion of good sanitation practices for the benefit of people's health and general well-being.

Nigeria is not left out as a nation to reckon with in the African sub-region, considering the enormity of the problems of poor sanitation practices as reported by Amadi and Iwuala (2005), Amadi (2000,2001,2002,2007, 2009, 2010), Okorie et al. (2000), Osibanjo (2002), George (2002), Sridhar(2006). It will be recalled, in the early 80s, that the streets and major roads, including the nooks and crannies in the cities, were taken over by waste dumps and stench produced from the decomposing materials. Such an ugly scenario was a national disgrace and embarrassment to the outside world. It portrayed the country in bad light which ultimately affected national development. All the major towns and cities suffered a serious setback from the heaps of waste dump and smelling environment with high rates of pest and disease transmission. Port Harcourt, capital of Rivers State, had its name "Garden City" changed to "Garbage City" owing to the mountains of waste dump in the streets. The situation was virtually the same in Ibadan, Lagos, Benin, Calabar, Owerri, Enugu, Kano, Maiduguri, Aba, etc., until the military took over power in 1983 and introduced the War Against Indiscipline (WAI) with emphasis on sanitation. But soon -- after the exit of the military -- the sanitation malpractices of the past have resurfaced.

Though sanitary situations in some of these cities have improved significantly, most of them are still in deplorable sanitary conditions with resultant proliferation of both communicable and non-communicable



diseases. The situation has even been made worse with effects of ozone layer depletion manifested in global warming. Worried by the rapid rate of urban decay in the country, the former President and Head of State, Chief Olusegun Obasanjo, at the first National Forum on Ecology and Environment, Abuja, in 1999, promised to deal decisively with problems of poor sanitation practices, which put Nigeria in the list of countries described as the dirtiest and the most unaesthetically pleasing (Osibanjo, 2002).

Similarly, the WHO / UNICEF Joint Monitoring Programme report (2009) on the progress towards meeting the Millennium Development Goals targets (MDGs) on sanitation, reports that Nigeria will not be able to meet the expected targets by 2015. Based on the above, it is imperative that the government should show more commitment to environmental health and sanitation and step up efforts backed by stronger political will and anti-corruption, the lack of which is the greatest challenge facing sanitation. Improving sanitation practices is achievable if the enabling environment is provided for it to thrive and the national environmental sanitation policy implemented.

According to the Federal Ministry of Environment, Nigeria (2005), environmental sanitation constitutes the principles and practices of effecting healthful and hygienic conditions in the environment to promote public health and welfare, improve quality of life and ensure a sustainable environment. It is also a range of interventions, designed to improve the management of excreta, sullage, drainage and solid wastes (WHO, 2005). Furthermore, Environmental Sanitation has been defined, in the Business Dictionary, as a set of activities aimed at improving or maintaining the standard of basic environmental conditions affecting the well-being of people.

The essential components of environment sanitation are solid waste and medical waste management, excreta and sewage management, food sanitation, sanitary inspection of premises, market and abattoir sanitation, pest and vector control, management of urban drainage, control of reared and stray animals, disposal of the dead, weed and vegetation control, hygienic education and promotion.

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According to the World Health Organization (1991), communicable diseases flourish where the environment fails to provide barriers against pathogens, and the risks are increased by overcrowding and importation of pathogens to which people are not resistant and increases in vector populations, owing to rapidly changing settlement patterns and disruption of ecological balance or relationships. It lists the following environmental conditions that facilitate disease transmission as: Lack of adequate and safe water supply, insanitary disposal of excreta, improper disposal of solid wastes, the absence of or inefficient drainage of surface water; poor personal / domestic hygiene and poor housing conditions. Environmental sanitation is broad-based and multi-faceted. Thus, for it to be effective in ensuring a quality environment for sustainable livelihood, a holistic approach based on epidemiological principles must be adopted, the reason being that environmental determinants of health act synergistically. A good environmental sanitation is a fundamental right to all Nigerians, in spite of their cultures, ages, and socio-economic levels.

Furthermore, environmental sanitation is the formulation and application of measures designed to protect public health. To sanitize is to make more acceptable by removing unpleasant or offensive features from the environment. The concept of environmental sanitation is, therefore, concomitant with the primordial systems of environmental cleanliness practiced by Nigerians before the advent of effective British colonial administration. However, for there to be environmental sanitation, there has to be environmental contamination and pollution. Pollution, so to speak, is the introduction by nature and man into the environment, of substances or energy liable to cause hazards to human health, harm to living resources and ecological systems, damage to structures or amenity or interference with legitimate uses of the environment (Noibi and Noibi, 1988). It may also be defined as the presence in the air, water or soil, of physical or chemical substances in such quantities, levels and duration as to adversely affect the environment and health of man, plant and animal.

Consequently, any substance that can cause pollution is regarded as a pollutant. The objective of environmental sanitation is to create and maintain conditions in the environment that will promote health and

prevent diseases. Environmental sanitation is the process of taming the environment so that it can no longer constitute a hazard to man (Lucas and Gills, 2003). The ultimate goal of environmental sanitation is to ensure a clean, safe and sustainable environment for promoting public health and well-being, so that the citizens may live happily and achieve their maximum potentials.

### **GENERAL OBJECTIVES OF NATIONAL ENVIRONMENTAL SANITATION**

A reciprocal relationship exists between man and his total environmental conditions, that is, physical, biological, social and economic. The aim of good environmental sanitation is to scientifically and technologically modify or re-engineers the human environment towards the maintenance and provision of health and prevention of diseases.

### **SPECIFIC OBJECTIVES OF NATIONAL ENVIRONMENTAL SANITATION**

To prevent insanitary conditions in the environment that is disease-/hazard-free.

To prevent aggravation of existing or unavoidable hazards by forestalling as much as possible their occurrence or at least, then, minimizing them.

To promote or create a healthy environment by encouraging individuals and corporate bodies to initiate good sanitary habits and practices.

To educate, and promote good environmental sanitation practices.

To promote economic empowerment and reduce poverty.

In pursuance of the above, the National Environmental Sanitation Policy of the Federal Ministry of Environment (2005) set out many strategies of attaining optimal environmental sanitation for the country with the overall objectives listed in box 1 below. The action plan recognizes the need for manpower development, development of legal instruments for environmental sanitation, promotion of partnership amongst stakeholders and creation of enabling environment for private sector

participation (PSP). It is also aimed at institutionalizing environmental sanitation consciousness as a lifestyle of Nigerians and ensuring that the guidelines on sanitary inspection of premises, control of animals, waste management, pest and vector control, markets and abattoirs, food and school sanitation are complied with. It also favors research in environmental sanitation as one of the objectives is to monitor and evaluate environmental sanitation services at all tiers of the government.

*Objectives of the National Environmental Sanitation Action Plan, January, 2005 (FMOE, 2005)*

1. *To create awareness on National Environmental Sanitation Policy (NESP) and Guidelines.*
2. *To Implement approved NESP and Guidelines.*
3. *Implement the provisions of the NESP on institutional arrangement.*
4. *Develop legal instrument on Environmental Sanitation.*
5. *Develop Manpower.*
6. *Promote Partnership amongst stakeholders.*
7. *Create Enabling environment for Private Sector Participation (PSP).*
8. *Provide technical Assistance packages to promote PSPs.*
9. *Advocacy through sensitization and mobilization of all stakeholders at all tiers of government.*
10. *Institutionalize sound Environmental Sanitation consciousness as a life style.*
11. *To comply with Policy Guidelines on Sanitary Inspection of Premises.*
12. *Control reared and stray animals.*
12. *To comply with Policy Guidelines on Excreta and Sewage Management.*
14. *To ensure free flow and adequate of the drainage system.*
15. *To comply with Policy Guidelines on Solid Waste Management.*
16. *To ensure sanitary disposal of the dead.*
17. *To comply with policy guidelines on Pest and Vector Control.*
18. *To comply with policy guidelines on markets and Abattoirs.*
19. *To comply with policy guidelines on Food Sanitation.*
20. *To comply with policy guidelines on School Sanitation.*
21. *Increase and improve financial resources Management in Environmental Sanitation Service Delivery.*
22. *To comply with the provisions in the policy and guidelines on machines and equipment procurement and maintenance.*
23. *To comply with the provisions in the policy and guidelines on standards for delivery of Environmental Sanitation services based on local conditionals, customs and practices.*
24. *To monitor and evaluate Environmental Sanitation services at all tiers of the government.*

## **NEEDS FOR SANITARY ENVIRONMENT**

- Protection and preservation of lives and life-forms
- Healthy conservation of natural environments (terrestrial/aquatic/aerial)
- Organized and safe evacuation of wastes (nitrogenous/organic/industrial/chemical/agricultural, etc.)
- Controlled exploitation, spoilage and /or pollution of the environment
- Promotion of healthy living, growth and survival

## **COMPONENTS OF ENVIRONMENTAL SANITATION IN NIGERIA**

**According to the Federal Ministry of Environment (2005), the following are the components of environmental sanitation:**

### **WATER SANITATION**

Access to safe drinking water is a basic prerequisite for health and sustainable development among the eight millennium development goals which countries of the world are expected to achieve by 2015. But it is bad news that Nigeria may not be able to meet the 75% target, based on the progress report by the WHO/UNICEF Joint Monitoring Programme (2008). An assessment of Nigeria's situation indicates that both water supply and sanitation coverage are the lowest in the world. It shows more people in the urban areas than rural communities have access to potable water (Iroegbu, 2009). The demographic health survey (NDHS) conducted in 2003 also revealed 65% of the urban population use safe water, while 70% of those in rural areas depend on poor sources from polluted streams, rivers, wells, boreholes, etc. In places served by public taps, the distribution pipes have leakages, causing cross contamination.

The problems posed by inadequate water supply have increased over the years owing to the frequent pollution activities. This situation includes an indiscriminate dumping of waste by industrial waste, health care waste, toxic chemicals, and oil company activities in the Niger Delta, among others. It is well known that poor water supply serves as a good vehicle for the spread of many tropical diseases such as cholera, typhoid fever, dysentery, gastroenteritis which cause childhood mortality / morbidity mostly, In the coastal regions, i.e., the Niger Delta. It has been reported

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that water pollution inflicts untold hardship on the inhabitants who now buy water from vendors of sachet water ("pure water") to drink. The sources of such water are suspicious and may be as bad as the polluted water in the area which the people avoid owing to their microbial / chemical content or quality. (WHO, 1991,1971; WAHEB, 1999; Salvato, 2002; Amadi, 2005; Osibanjo, 2002; FMENV, 2005).

### **SOLID WASTE MANAGEMENT**

More than 87% of the Nigerian population adopt waste disposal methods that are generally unsatisfactory and not environment-friendly. Common practices of indecent waste management include the following:

- a. Dumping into the drains, along the road and street corners, nearby bushes, water fronts, open land or undeveloped plots burrow pits etc.
- b. Waste collection and storage in basin, open bucket, basket, wheelbarrow, polythene bags, etc.
- c. Transportation of waste in hand pushed trucks or carts, wheelbarrow, by underage children.
- d. Employment of lunatics to transport waste to central collection points.
- e. Open burning of waste near dwellings, at central waste depots or dump sites.
- f. Sweeping waste into the drains by road sweepers.
- g. Transportation or hauling of waste to dumpsite in open vehicles (tippers) by unqualified contractors and personnel.
- h. Use of low land, marshes or swamp, open land or burrow pits in the out-skirts of city settlements for the dumping of waste, etc.
  
- i) These practices create noxious conditions favourable to the breeding of flies, mosquitoes and rats, which are involved in disease transmission, e.g., malaria, cholera, typhoid, schistosomiasis, hookworm, rat-bite fever, leptospirosis, etc. Also, they cause city bright and odour nuisances, thus making the environment unattractive to tourists and visitors. A typical example can be seen in Appendix 3 below.

In Nigeria, waste collection, storage, transportation, treatment and

disposal are carried out recklessly against environmental health standards. The services are haphazardly organized and lack proper organization and planning. As a result, indiscriminate waste dumps litter the streets and major roads in most cities in Nigeria. This may obstruct the free flow of traffic and block the drainages. It may also attract flies and rats in the neighborhood and produces foul odours from the decomposition of waste. The waste dumps equally block the gutters, resulting in the flooding of houses, property damage and disruption of viable economic activities.

Another disturbing issue is the practice of dumping toxic and infectious waste. This affects proper waste collection and disposal, as the pathological materials get mixed up with domestic waste, so presenting special health risk to human health, especially scavengers and waste collectors because of the poisonous/toxic nature of such materials. Some of the toxic and infectious pollutants could pass easily into rivers, wells, boreholes, etc., unnoticed and cause disease if consumed by man, resulting in either acute or chronic health conditions.

#### **EXCRETA AND WASTE WATER MANAGEMENT**

One of the characteristic features of poor housing in the human settlement is the absence of sanitary toilets and bathrooms in houses. In Nigeria, the issue is a major challenge because of the increasing tenant population in urban and semi-urban centre. Lack of town planning, building regulation and enforcement of building codes by the government, coupled with the high level of poverty in the land, contributes to the ugly situation.

Available statistics from the Nigerian Demographic Health Survey (2003) show only 10.1% of the urban population have sanitary toilets, while 61.1% use pit latrines and the remaining 28.7% use flush toilets. In the rural areas, the reverse is the case, as 34.1% of the households have no toilets all. Therefore, they resort to open defecation and urination in the neighborhood, near dwellings, uncompleted houses, vacant plots, waste dump, roads and street corners, etc. This is usually done at night and in the early hours of the morning (FMENV, 2005).

From all indications, Nigeria might not meet the Millennium Development Goals target set for basic sanitation coverage by 2015. Already, the WHO/UNICEF Joint Monitoring Programme report on the

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MDGs equally shows Nigeria is lagging behind the 67% coverage for basic sanitation globally (JMP, 2008).

This scenario is not good for Nigerians, given the growing disease prevalence that abounds and the attendant morbidity and mortality rates particularly in children. In addition, the practice of open defecation and discharge of sewage in the environment without treatment contaminates sources of water supply, e.g., rivers, ponds, wells, boreholes, lakes, etc. The dangers of improper excreta and sewage disposal are greatest in the Niger Delta area, where the numerous river systems and creeks allow easy transport and distribution of pollutants. The northern parts of the country suffer the same fate, because of the arid conditions that make their case a peculiar one. All of these contribute to poverty and underdevelopment, as it affects farming and fishing, which are the predominant occupations of the people and sources of their livelihood (Amadi and Iwuala, 2005; Moltat and Linden, 1995; FMENV, 2008; FRN/ VISION, 1997; FRN, 2000; SUNJU ALISON, 2002). See appendix 4 below.

The reckless construction of poor flush water system toilets and discharge of sewage, including direct defecation into the river, stream, bush and natural drainage channels, constitute potential health dangers. These are the main sources of both parasitic and faeco-oral infections to man, especially cholera, typhoid, dysentery, amoebiasis, ascariasis, etc., which cause high mortality/morbidity rates, particularly in children under 5 years of age. It is also a major cause of water contamination and food poisoning responsible for diarrhoea which kills children easily (Amadi and Iwuala, 2005; Amadi, 2007; Maduka, 2006; and WHO, 2004).

The dangers of dumping sewage into water without treatment also expose people to diseases which have been found to contain various quantities of pathogens. For example, investigations show that excreta dumped into water without treatment may contain up to 10 million viruses, 1 million bacteria, 1000 parasitic cysts and 100 worm eggs. If such contaminated water is consumed without proper disinfection, there is no guarantee of safety of the individual so affected (Lucas and Gills, 2003; Park, 2007; Amadi, 2007). See appendix 5

The poor water supply from commercial boreholes, pure water dealers and water truck vendors can also be a source of health risks to the people since they are not monitored. It is estimated that about 76.09% of the people rely on water vendor trucks for their needs (UNDP, 2006; Jacob and Mendie, 2003; WHO, 1991). Evaluation of water supply services and regular monitoring can be the best options for addressing this problem if the goals of IYS are to be achieved.

### **HOUSING AND URBANIZATION**

According to public health experts, the manner in which a house is built influences the health of the occupants. Thus, poor quality houses can become serious threats to individuals in terms of safety and protection from harsh weather, as well as other environmental hazards.

In Nigeria, houses that meet the required standards for healthy living are scarce. As such, people have no alternative than to live in make shift accommodation, which is unplanned, haphazardly constructed with poor quality materials and structurally unsafe. Overcrowding is another problem in the cities where more than 10 persons share a single room, instead of a maximum of 3 adults, as stipulated by law. The houses also stand close to each other without any available space for access road, resulting in the difficulties of waste collection, emptying of septic tanks, and drainage of run-off/ waste water from households. This situation also prevents the free flow of air in and out of the living quarters, a situation that can be injurious to man.

Under such conditions of poor sanitation arrangement, opportunities for disease transmission increases, which is why cases of acute respiratory infections, tuberculosis, whooping cough, pneumonia, bronchitis, diarrhoea, worm and parasitic diseases, cholera, typhoid, food poison, etc., are rampant in the urban slums (WHO, 1991,1971; Salvato, 2002; Amadi and Iwuala, 2005; Amadi, 2007). See appendix 5

In many states of Nigeria, urban and rural housing constitutes major challenges in the cities where many are living in makeshift accommodation without basic sanitary facilities, such as toilets, drainage and solid waste collection systems, ventilation, etc. Besides, the houses are usually clustered, unplanned or haphazardly built and over-crowded

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with up to 4 - 10 persons occupying a room, instead of the maximum of two adults and two children( less 10 years) per room (FMENV, 2005). This makes it conducive for disease transmission and spread among the occupants and other psychosocial problems peculiar to such neighborhood. The reason for such an ugly scenario is the issue of poor planning and unregulated patterns of buildings without consideration to health and access roads, making waste collection/evacuation very difficult (WHO, 2004; Merkel and Otai, 2007; Guy *et al.*, 2002). When Housing is adequate and provided in a clean and safe surrounding, it suggests that both the living, working and recreational environments are such that provides comfort, removes risks of accidents, avoidable disasters, crowdedness and disease dissemination, leading to a healthy and subsequent productive nation.

#### **POTABLE WATER SUPPLY**

This means the availability of water in such quantity and quality that satisfies our basic water requirements, without posing any danger of transmission of diseases or noxious substances prejudicial to health. The most common sources of water for domestic use include rainwater, surface water, and groundwater. Groundwater can be the least threatening of all water sources. The sources of groundwater, usually wells and springs, are often untainted by waste disposal. Rainwater and surface water, on the other hand, are often considered the least potable, and requires treatment before consumption. The most threatening source of water is often surface water. If waste is not disposed of properly, it can mix with water on the ground that may be collected for drinking and cooking. Contamination can be caused by household trash and human waste. The consumption of tainted water can lead to new disease outbreaks and the spread of outbreaks.

The important roles which water play in the life of man cannot be overstressed, particularly in the domestic scene, industrial sector and in promoting health. However, potable water supply presents a major public health challenge in the urban setting in view of the frequent pollution through improper system of managing waste from the homes, manufacturing industries and oil pollution activities. The effects of water pollution problems are more severe in the coastal and marine communities, since they are at the receiving end or terminus of all

pollutants discharged elsewhere. This causes serious water shortages and scarcity for the people who are virtually dependent on river water for their daily needs. It is also the key factor responsible for disease prevalence (Osibanjo, 2002; UNDP, 2006; Singh *et al.*, 1995). The situation of potable water supply in Nigeria is worrisome, as most of the population relies largely on water truck vendors, private commercial boreholes. In some major towns, e.g., Aba, in Abia State, potable water supply is very poor less than 25% coverage (Amadi, 2001).

### **FOODSANITATION**

Food hygiene and safety surveillance services can be used as a good check against contamination and food poisoning. The hygiene of food handling is a vital aspect of environmental health, but it has been neglected and not taken seriously by the operators of such business and successive governments. This accounts for the deteriorating sanitation in hospitality industries -- hotels, restaurants, fast food shops, and domestic kitchens. Many cases or complaints of food poisoning and common illness which people suffer are acquired simply from the food they eat which may be contaminated and contain bacteria, viruses, parasites, viable worms' eggs/cysts and chemicals. The poor handling methods and dirty habits (personal hygiene) of food handlers facilitate disease transmission. The menace of food-borne diseases attributable to poor food hygiene practices of food handlers and premises is currently on the increase in the rural and urban slums. The trend may even worsen as many Nigerian now eat outside their homes because of inability to prepare their own food for lack of time, fund and unwillingness to do so. This trend calls for re-orientation on basic food-handling practices backed up with enabling laws and improved enforcement.

### **SANITARY INSPECTION OF PREMISES**

A premise is a house or building with its ground and appurtenances, while premises are the buildings and land that a shop, restaurant, company, etc., use. In environmental health sciences premises may mean -- and include -- passages, buildings, land, tenement, vehicles, vans, ships or vessels and aircraft in any port or on any inland waters used or intended for use by man, which may include dwelling houses, hostels, schools, recreational facilities, factories, prisons, or vessels on any inland waters. Furthermore, premises may include structures or institutions,

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such as prisons, schools, hospitals, religious homes/camps, food vans, recreation ground and mobile carts.

The objectives of sanitary inspection is to assess the health condition of premises and abate nuisance(s) and render premises conducive for healthy living (Olurunda *et al.*, 2009; Onibamidele *et al.*, 2009).

The aim of sanitary inspection of premises is to maximally improve the quality of life of man through sustained environmental sanitation practices in our community and homes based on sound scientific, engineering and technological approaches (FMEV, 2005).

### **MANAGEMENT OF URBAN DRAINAGE**

Urban drainage is one important issue that has suffered serious neglect since post-independence. The functional drainage or sewage systems in Nigeria's major cities that existed during the colonial period are now mere relics in such places owing to lack of maintenance. The type of drainage system provided in the towns and cities are not good enough, owing to poor construction defects as it does not allow waste water to flow. A major problem is the attitude of converting them into waste dump and toilets. The practice causes urban flooding and encourages mosquito-breeding, including the contamination of surface and ground water sources. Also, unregulated building designs/patterns, erection of houses and poor road constructions -- without good drainage -- complicates the problem.

### **PEST AND VECTOR CONTROL**

Pests and vectors have been known for a very long time for their significant roles in the transmission of sanitation-related diseases. Some act as agents of disease, while others destroy household articles, valuable properties, food items and crops. Pests and vectors particularly transmit parasitic and viral diseases, which include malaria, yellow fever, filariasis, schistosomiasis, onchocerciasis, leishmaniasis, loiasis, lassa fever, etc.

Of all vectors, mosquitoes and rats are the most popular, because of their cosmopolitan nature and behaviour, plus involvement in spreading deadly diseases (e.g., malaria). Effective control of their population or propagation entails proper waste management and control of weed and

vegetation which provide source of food and hiding places for their survival. Many parts of Nigeria are not left out, either, in the issue of pests, as no reliable measures are available in the area to contain pest havoc. What is on ground are quacks who parade as pest control specialists, which is against the national policy on pest/vector control.

#### **ABATTOIR SANITATION**

Most diseases that affect people come from meat that has been contaminated at the slaughter or abattoir and in the course of transportation. Like hotels and restaurants, abattoirs also need to meet certain basic sanitary standards for prevention of meat contamination and zoonotic diseases, e.g., water supply, good drainage, waste disposal, transport facilities, including regular cleaning and hygiene of equipment, etc. When such facilities are not provided and sanitation of the slaughter is not maintained, definitely the meat products will be contaminated. Transportation of meat in passenger vehicles, wheel barrows, motor bikes, etc., therefore, should be avoided. Similarly, hawkers or meat vendors must ensure protection of meat products from dust, flies and other contaminants in the environment (FMENV, 2005; Salvato, 2002).

The level food sanitation, mostly meat hygiene, in Nigeria leaves much to be desired. Meat hygiene practices in Nigeria are generally known as not being of a high standard, and this, to a large extent, plays a significant role in the etiology of food-borne diseases rampant in the country. The pictures bellow may help to explain the meat hygiene scenario in our abattoirs and markets across the country appendix 6,7,8 and 9 below.

#### **SCHOOL SANITATION**

Generally, problems of poor sanitation or environmental health service delivery stem from lack of understanding and ignorance of environmental sanitation concepts. Both the government and the public are to blame for the current state of sanitation decay in our society. School sanitation is an aspect of environmental health and school health services which have been neglected for so long, yet they serve as means of promoting a clean environment and healthy development. Schools provide avenues for children to learn good virtues, including clean habits, so they may grow up to become responsible citizens and more environment/healthy conscious. It is also said that when children learn

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sanitary habits, they can, in turn, impact on their parents and help transform their behaviours and attitudes to the environment, as well. Unfortunately, schools have failed in this important function.

Today, both school proprietors and education authorities compromise standards in establishing educational institutions for political reasons and selfish interests. That is why pupils/students are made to learn in dirty and unsafe environments which are located in the midst of residential houses, centres of commercial activities and churches/prayer houses using generating sets, loudspeakers, and other appliances which are sources of environmental noise and other hazards. Even in universities and colleges, there is gross sanitation decay in hostels, classrooms and surroundings.

Furthermore, most schools do not have sanitary facilities. For example, they don't have toilets, good water supply, proper ventilation and other sundry provisions necessary for effective teaching and learning. In the face of these hazards, adequate teaching/learning cannot take place, and this may have contributed to the fallen standard in education, as well as the high rates of infections, prostitution, cultism, lawlessness, drug addiction and other delinquent behaviours among students. Parents/teachers associations, the education ministry, and its agencies, environmental health experts and well-meaning individuals must rise up to the challenge in making the learning environment in schools conducive for teaching and learning (WHO, 2004; Effiong and Samuel, 2006; Dew et al., 2000; Salvato, 2002; Mc Athur and Bonnefoy, 1997; Mac Mahon, 1992).

The sanitation standards in most of our schools, crèches and tertiary institutions are very poor. Toilets, when available, are not functional owing to lack of water to flush the toilets, and this situation leads to pupils' defecation at corners and nearby bushes. In other instances, where toilets are provided, pupils vandalize them. In the schools, general environmental sanitation is poor. Overcrowding is a major threat to the children's health in most of our schools. Most of the infectious diseases occurring in the schools are closely linked with overcrowding and dirty environment. These factors have a serious health impacts with attendant social and economic consequences, including school absenteeism.

A cursory look at sanitation situations in schools and other public institutions, government-owned and private alike, depicts a sorry situation. Figure 10 shows an access road to a school, while figure 11 shows a double compartment/alternating ventilated improved pit latrine used because of lack of water to operate other systems. The thick litter of polyethylene bags on the slab behind the toilet is a testimony of how the toilet is used. That is, excreta are wrapped in the bags and posted behind the toilet. Here facilities are lacking alongside positive health behavior this is shown in figure 11.

### **DISPOSAL OF THE DEAD**

In a man's life, death is inevitable, and, therefore, the remains should be disposed of in a sanitary manner. Hence, the establishment of cemeteries is indispensable. But in many urban centres today, cemeteries are fast disappearing, as they are being developed or sold out rightly owing to population pressure, scarcity and high demand for land. In some parts of Nigeria, for instance, people buy land to bury the deceased, since there is no cemetery, while those who cannot afford to buy, bury anywhere under cover to avoid being caught. Most people even bury in their houses to save cost. The problem inherent in this unhealthy practice is the danger of environmental pollution and contamination of surface/ground water sources. The danger is even greater when people die of infectious diseases like HIV/AIDS. The problem, therefore, calls for immediate government action in establishing or re-establishing government or private cemeteries in Nigeria. Communities should be educated on how to maintain cemeteries in their localities and adequate sanctions imposed on defaulters (Kapoor, 2007).

### **HYGIENE EDUCATION AND PROMOTION**

Hygiene education programmes provide information and understanding about those behavioural changes which bring the greatest health benefits and proposes gradual improvement both in practices and hygiene facilities. Hygiene education means helping individuals, families and communities to become aware of the links between poor hygiene behaviours and disease<sup>5</sup>. It also means encouraging and helping people to improve those behaviours which, if applied, will lead to the greatest reduction in diseases. At the level of households and communities, hygiene education will help people to find ways of improving their

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situation by designing and constructing their own improved facilities.

Hygiene education and communication support should not solely be a device to make the community accept and use what sanitation technology is provided. It should promote informed decision-making and empowerment of communities to tackle the cause of cholera and other diarrheal diseases. This will involve giving the communities opportunities to participate in decision-making and in the selection of sanitation technologies that are most appropriate to them.

### **Public health importance of environmental sanitation**

Nigeria is one of the developing countries in the West African part of the globe. With an alarming population of about 150 million people and without adequate facilities to accommodate this population rise, the nation is, therefore, faced with a high break down of amenities, mainly owing to undue-pressure. The resultant effect is a total environmental decay.

The environment in which people live influences their health. A healthy population is dependent upon a healthy environment. In Nigeria, poor environmental quality is responsible for up to 25% of all preventable ill health. All over the globe, the most immediate problems in the world are ill health and premature death caused by biological agents in the human environment, i.e., in water, food, air and soil. They contribute to the premature death of millions of people, mostly, infants and children, and to the ill health or disability of a greater percentage. This problem is acute in most developing countries like Nigeria, where Millions of infants die every year from diarrhea diseases, largely as a result of contaminated food or water. Over 100 thousand people die from malaria each year and up to 1 million are infected.

Only 12% of urban population is provided with some sanitation facilities. Inadequate provision of safe drinking water, improper disposal of human waste and lack of adequate systems for disposal of sewage and refuse lead to unhealthy and unhygienic conditions. This situation, coupled with overall ignorance of personal and environmental hygiene, is the main cause of a large number of water-borne diseases. Faecal contamination can spread the infection either because the excreta already carrying the infection pollutes the drinking water consumed by households, or is

mechanically transmitted to food by insects which sit or breed on the infected faecal matter. 80% of those lacking adequate sanitation live in rural areas. Projected urban population growth suggests that urban services will face great challenges over the coming decades to meet fast growing needs.

A lot of environmental hazards have been posed by the indiscriminate refuse and sewage disposal in Nigeria. This situation is usually noticed in the urban areas. The problem has been attributed to the failure of the various city authorities to plan and manage the mounting refuse heaps in various street corners. Most drainage channels are blocked by refuse, leading to flooding and providing stagnant water, which breeds mosquitoes. Refuse heaps in our urban centers blithe the aesthetic nature of our otherwise beautiful cities. Rodents and other disease-causing germs, including such reptiles as snakes find home as well as sources of food in these refuse heaps. The refuse and other wastes generated are only moved away from our consciousness but not disposed in a manner as to promote public health. The wastes most of the time are burned at dump sites releasing toxic and hazardous substances such as dioxins and furans, which are cancer-causing agents, into the atmosphere.

Exposure to ionizing radiation can be mutagenic, carcinogenic and teratogenic. Also, it has been associated with the cause of premature aging, impaired fertility and senile cataracts. On the other hand, contamination of water can lead to...

**a. Water-Borne Diseases:** These are diseases transmitted by water where water acts as a passive vehicle for infecting agents, e.g., cholera, typhoid, bacillary dysentery, viral hepatitis, leptospirosis, giardiasis, gastro-enteritis.

**b. Water-Washed Diseases:** These are diseases due to lack of water. Poor personal hygiene favors its spread, e.g., scabies, skin sepsis and ulcers, yaws, leprosy, lice, typhus, trachoma, conjunctivitis, bacillary and amoebic dysentery, salmonellosis, worm infestations, etc.

**C. Waster-Based Diseases:** These diseases infected by agents spread by contact or ingestion of water. An essential part of the life cycle of agents takes place in aquatic animals, e.g., Schistosomiasis, dracunculiasis.

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**d. Water-Related Diseases:** These are diseases transmitted by insects living close to water, e.g yellow fever, dengue, encephalitides, filariasis, malaria, onchocerciasis, sleeping sickness.

**e. Faecal-Disposal Diseases:** These are caused by infecting agents by eating uncooked fish and other food, e.g., clonorchiasis, diphyllbothriasis, fasciolopsiasis, paragonimiasis.

Noise, which is an environmental pollutant, has two deleterious effects on humans. These are auditory and non-auditory effects. The auditory effects include auditory fatigue and hearing loss; The non-auditory effects are interference with speech, annoyance, decrease in efficiency and physiological changes like increased heart rate, respiration, intracranial tension (ICT) blood pressure and sweating. Excess sound also interferes with sleep and is said to cause visual disturbances like distorted color perception and reduced night vision. Noise greater than 120 dB can damage the cochlea, resulting in an irreversible permanent hearing impairment.

#### **ENVIRONMENTAL SANITATION PRACTICE IN NIGERIA**

Environmental sanitation has remained poor in Nigeria. About 87% of Nigerian use inefficient and insanitary methods of refuse disposal. Access to sanitary facilities is generally poor. In Nigeria about 12% of urban population has no toilet facilities of any kind. 55% use pit latrines while 31% use flush toilets. The state of food storage, preparation and preservation at homes, markets, and abattoirs is also very unwholesome in most instances (NDHS, 1999; FMENV, 2005b).

Over the years, poor environmental sanitation has remained one of Nigeria's greatest challenges in achieving a safe environment for its citizens; an environment they can live in happily and contribute to national development. Solid waste disposal, for instance, creates much of the environmental problems owing to the uncoordinated system of management by government agencies and indiscriminate dumping practice by individuals or communities. In urban centres, waste collection is irregular, leaving most of the dumps uncollected they are normally burnt. Waste segregation at source is not practiced; household and industrial wastes, including toxic waste are co-mingled and disposed

of, leading to soil and ground water pollution (FMENV, 2005; Osibanj, 2002).

In all states of the federation, including Abuja, solid waste dumps exist in the towns and cities. These, together with poor human settlement patterns characterized by insanitary toilets, stagnant pools of waste water, heavy presence of flies, mosquitoes and rats including foul odours, expose the inhabitants to serious health risk, thereby making life not worth living. The most prevalent diseases are malaria, typhoid, cholera, dysentery, acute respiratory infections, as well as parasitic infections from improper excreta disposal. These infections cause high morbidity and mortality rates, especially diarrhoea in children in the country.

The situation is deteriorating by the day, as efforts by the government have not been successful. Because of the poor sanitary standards, Nigerian cities are also described as the dirtiest, most insanitary and least aesthetically pleasing in the world (FMENV, 2005; Mabogunje, 1996). Details of the actual scenarios across the country are discussed below to highlight some of the fundamental issues militating against the promotion of good sanitation practices in the Nigeria.

At the beginning of 2000, two-fifths of the world's population lacked access to improved sanitation, the majority of which is from Africa and Asia (Gupta and Ghai, 2007). Official statistics from WHO and UNICEF suggests that about 3.8 billion (60%) in 2004 had access to "improved" sanitation globally. In other words, 4 out of 10 people around the world had no access to improved sanitation. The lowest coverage is recorded in the Sub-Saharan Africa, South Asia, and Eastern Asia, and these remain areas of greatest concern. 'Improved' sanitation facilities are those that reduce the chances of people coming into contact with human excreta and are likely to be more sanitary than unimproved facilities (WHO and UNICEF, 2006). The underlying problem or issues contributing to the challenging situation include lack of political will, financial resources, weak institutional frameworks, neglect of consumer preferences and cultural beliefs.

Sanitation coverage in rural areas is less than the one in urban settings, even though 80% of those lacking adequate sanitation live in the rural

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areas – some 1.3 billion in China and India alone. Projected urban population growth, especially in Africa and Asia, suggests that urban services will face great challenges in the future to meet with growing needs. To quickly expand the global sanitation by 2015, coverage must be to the MDGS target level of 75%. Investing in sanitation infrastructures involves a long project cycle. If the MDG sanitation target is to be achieved, innovative approaches need to be developed to reduce the time span from policy making to services delivery (WHO and UNICEF, 2006). Millions of people die each year from preventable water-borne diseases, as a result of inadequate sanitation and hygiene practices.

Environmental sanitation efforts in Nigeria may not be traced beyond the era of colonial administration for want of relevant data. The colonial masters instituted serious sanitary measures for the promotion and maintenance of public health like the provision of centralized sources of potable water, especially in the then emerging major cities of Abeokuta (1911); Lagos (1914); Enugu, Ijebu Ode (1927); Aba, Onitsha and Makurdi (1931); Jos (1935); Okene (1936); Porthacourt and Ibadan (1942). Technologies for waste management were also adapted according to the growing needs of the towns; hence, wastes, especially, night soils were disposed of in pit latrines, bucket latrines, trenches, etc. Stringent sanitary laws made to apply in their home countries were by extension transferred and applied in Nigeria.

Faced with the problem of manpower and environmental and public health education, the colonial masters confronted the challenge by the establishment of rural health training institutions, which by 1945 were spread across the regions of the country. Some of these training schools are schools of hygiene Aba, Kano, Lagos, etc. Apart from the school of hygiene in Kano, all the schools of hygiene have metamorphosed into Colleges of Health Technologies in Nigeria, transformed to award Ordinary National Diploma and Higher National Diploma in environmental health and other fields. This not only produced the needed manpower then, but also facilitated the development and dissemination of local technologies for water sanitation, excreta disposal, food quality control and basic personal hygiene and education. Thus, Nigeria was able to keep pace with the rest of the world in handling the menace of plague, influenza and small pox, which was eventually globally eradicated in

1978( Ebisike, 2008).

The growing need for self rule made African nationalists Nigeria inclusive- to struggle for and obtain independence without adequate adaptation of the technology and culture of their colonialists and the development of indigenous technology in this, and indeed other areas were beclouded in the preoccupation for the development of administrative and political machinery to control the instrument of power and governance as relinquished by the colonial masters. Hence, the period between 1960 and late 1980s witnessed a great decline in the provision of the right kind of facilities by governments and in the citizenry poor attitude and behaviour to promote environmental hygiene. The oil boom and the concomitant corruption it generated in governance tended to shift emphasis from preventive to curative health care where inflated and sometimes nonexistent contract jobs like the building of teaching hospitals, supply of laboratory equipment and drugs (real or fake) were the order of the day.

The dumping of toxic waste in 1991 in Koko, a small town in the then Bendel State, jolted the Nigerian government into spear-heading efforts in the promotion of sanitation in the country. Hence, some institutional frameworks, regulations and policies were developed and instituted. In 1991 alone, the National Effluent Limitations Regulation, the National Environmental Protection Management of Solid Waste Regulation and the National Policy on Environment were developed. Within the same period and in 2002, the Federal Ministry of Environment, Federal Environmental Protection Agency (FEPA), National Agency for Food and Drug Administration and Control (NAFDAC) and Environmental Health Officers Registration Council (EHORECON) were established with varying mandates that would ensure environmental control and sanitation. Within the same period, the government embarked on mass education for attitudinal change with the establishment of the National Orientation Agency, which has continued to launch behavioural change programmes like the War Against Indiscipline, National Environmental Sanitation Day's Education amongst others. The situation now is that the sanitation level in Nigeria is yet to be admired, probably owing to the level of poverty and corruption.

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### **SANITATION AND POVERTY**

The level of poverty in the country, on a general scale, does not give impetus for an average household to afford the basic facilities that will encourage good sanitation, namely safe water supply, good housing, waste management, food hygiene and indeed good knowledge and positive health practices. Among the African countries, poverty is said to be on the increase and is a big worry. In Nigeria, the total population living in poverty stood at 66% as at 1996, and the proportion of the extremely poor stood at 29%. These figures also reflected in other UN Development indicators where Nigeria is rated far below the ladder among other countries. Our population access to health services is 33% and about 43% of the population having access to potable water. This is the case with the developing or rather fourth-world countries. Thus, our sanitation profile is such that we have open drains mainly with no public sewers and popular excreta disposal systems as pit latrines, VIP latrines, aqua privy and septic tank systems. In this absence of sewerage systems, excreta and septic sludge are unhygienically disposed of in the bush. This practice promotes fly breeding and increases helminthic and other parasitic infections in the communities.

This situation is compounded by massive corruption in all aspects of our national lives. Both people in high places and the common community inhabitants even see intervention facilities from the so-called "development partners" as brisk opportunities to improve on their personal earnings with the result that such facilities were never provided in the design capacity or quality that can serve the people positively. Provision of pipe-borne water continued to dominate campaign speeches of politicians to communities and wards even after fifty solid years of self rule. Even when such facilities see themselves through the budgetary process, corruption turns implementation to rehabilitation or the painting of the dilapidated /disused colonial infrastructures. Only very few outstanding examples abound, hence the earlier noted gross shortfall.

### **THE ROLE OF GOOD SANITATION IN HEALTH AND PRODUCTIVITY**

The role of good sanitation of the environment cannot be stressed enough, given that improvement of environmental conditions was

recognized as crucial to public health even before discovering the microbes and their link to diseases and death. Apart from cholera and other diarrheal diseases, numerous other diseases come to us through poor environmental conditions and faulty habits<sup>9,10,11,12,13</sup>. Thus, with good environmental sanitation, communicable and most non-communicable diseases will be a thing of the past, hence promoting health and longevity and improving productivity as numerous man hours lost in hospitals and other health care centers would have been gained. Also, the government spending on curative services will be channeled to improving preventive facilities and building industries. Good environmental conditions encourage learning at institutions and promote concentration and productivity in industrial settings. Even at leisure or recreation, sanitation promotes good psychological dispositions and indeed positive health behaviour. On the contrary, poor environmental conditions encourage stress, poor concentration, increased accidents, diseases and invariably death.

#### **Economic benefits of Environmental Sanitation**

The economic benefits of environmental sanitation can simply be summarized with the paradox which holds that "Health is wealth" and by extension "a healthy nation is a wealthy nation." Some of the economic benefits include...

- i. A proper and efficient environment wards off diseases, thereby promoting good health and longevity.
- ii. A good environment attracts investors.
- iii. It improves the aesthetic value of every nation.
- iv. It has an economic cost advantage in that people spend less to ward off diseases than to embark on disease cures.
- v. It encourages international trade thereby generating revenue for the nation.
- vi. It enables a high global rating for the nation and elevates our reputation.
- vii. A clean environment can serve as huge collateral for any nation in terms of loan or grants.
- viii. It creates room for cross fertilization of resources, since most foreigners would settle in the place, introducing their economic strategies which will boost the existing economy inter-alia.
- ix. It enables a nation to be part of the global campaign on the

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preference for preventive medicine in place of clinical medicine.

### **EXPOSURE TO TOXIC/POISONOUS SUBSTANCES IN THE ENVIRONMENT**

This is the study of the adverse effects of environmental chemicals on human health. The assessment of the toxic effects of chemicals on humans can be done with the use of standard animal models as well as epidemiological evaluations of exposed human populations.

### **TYPES AND SOURCES OF AIR POLLUTION**

Air pollution is the presence of unwanted materials in the atmosphere at a quantity capable of eliciting adverse health and environmental problems. The actual composition of unpolluted air is unknown because humans have been polluting the air for thousands of years. There natural contributors to air pollution like terpenes from plants, smoke from forest fires, and fumes from volcanoes.

**Gaseous pollutants:** Pollutants that are gases at normal temperature and pressure as well as vapours evaporated from substances that are liquid or solid. In this category, we have the likes of carbon monoxide (CO), hydrocarbons, hydrogen sulphide (H<sub>2</sub>S), nitrogen oxides (N<sub>x</sub>O<sub>y</sub>), ozone (O<sub>3</sub>), oxides of sulphur (S<sub>x</sub>O<sub>y</sub>), carbon dioxide (CO<sub>2</sub>) and other oxidants.

**Particulate pollutants:** These consist of fine solids and liquid droplets which are suspended in the air. Examples include dusts, fumes, mist, smoke and aerosols.

#### **Sources of air pollutants and their effects**

**i. Natural pollutants.** Pollutants of this origin are formed and emitted naturally. A volcanic eruption is capable of emitting particulate matters and gases such as sulphur dioxide, hydrogen sulphide and methane. Forest fire releases pollutants in the form of smoke, unburned hydrocarbons, CO, nitrogen oxides, and ash. Dust storm is a common source of particulate matter, and oceans produce aerosols in the form of salt particles. Plants produce pollen and spores, which cause respiratory problems and allergic reactions.

**ii. Anthropogenic pollutants.** Pollutants in this category are from

three basic sources: 1) combustion sources that burn fossil fuel for heating and power; or exhaust emissions from transportation vehicles that use gasoline or diesel fuels; 2) industrial processes; and 3) mining and drilling. The main pollutants of combustion origin include fly ash, smoke, sulphur, and nitrogen oxides, and oxides of carbon. Transportation sources are major sources of air pollution and include smoke, lead particles from tetraethyl lead additives, CO, nitrogen oxides, and hydrocarbons.

**iii. Indoor pollutants.** These involve pollutants from home and non factory public buildings such as offices and hospitals. Pollution can come from heating and cooking, pesticides, tobacco smoking, radon, gases, microbes from people and animals.

#### **Health effects of air pollutants**

Illness may result from chemical irritation of the respiratory tract, with certain sensitive subpopulations being affected: 1) very young children, whose respiratory and circulatory systems are poorly developed; 2) the elderly, whose cardio-respiratory systems function poorly; and 3) people with cardio-respiratory diseases such as asthma, emphysema, and heart disease. Heavy smokers are also affected more adversely by air pollutants.

**Carbon monoxide:** This combines readily with haemoglobin (Hb) to form carboxyl haemoglobin (COHb). This combination prevents the transfer of oxygen to tissue. The affinity of haemoglobin for CO is approximately 210 times its affinity for oxygen. Carbon monoxide intoxication is evidenced by headaches, dizziness, nausea, and breathing difficulties. The effects of low concentration of CO over a long period can be implicated in respiratory and heart disorders.

**Sulphur oxides:** SO<sub>2</sub> is a common component of polluted air that results from the industrial combustion of coal. It tends to adhere to air particles and enter the inner respiratory tract, where it is not effectively removed. In the respiratory tract, SO<sub>2</sub> combines with water to form sulphuric acid, resulting in the irritation of the mucous membrane and bronchial constriction. This increases the sensitivity of the airway to other airborne toxicants.

**Nitrogen oxides:** Nitrogen dioxide (NO<sub>2</sub>), a gas found in photochemical

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smog, is also a pulmonary irritant and is known to pulmonary edema and haemorrhage. The main issue of concern is its contribution to the formation of photochemical smog and ozone, although nitrogen oxide also contributes to acid deposition.

**Ozone:** A highly irritating and oxidizing gas is formed by photochemical action of ultraviolet (UV) light on nitrogen dioxide in smog. The resulting ozone can produce pulmonary congestion, oedema, and haemorrhage.

**Lead:** lead can impair renal function, interfere with the development of red blood cells, and impair the nervous system, leading to mental retardation and even blindness. The routes of entry are by ingestion and inhalation

**Solid particles:** particles of dust, fibres from coal, clay, glass, asbestos and minerals can lead to scarring or fibrosis of the lung lining. Pneumoconiosis, a condition common among coal miners that breathe coal dust, silicosis, is caused by breathing silica-containing dusts, and asbestosis from asbestos fibres.

## **ECOTOXICOLOGY**

This is the study of the effects of environmental contaminants upon the ecosystems and its constituents. Ecotoxicology involves the study of the adverse effects of toxicants on myriads of organisms that compose the ecosystem, ranging from microorganisms to top predators. It is worthy of note that the comprehensive insight into the effects of chemicals in the environment requires assessments ancillary to toxicology such as the fate of the chemical in the environment and the interactions with abiotic components of ecosystem (Curtis D., 2007).

### **Environmental persistence**

The elimination of toxic chemicals can be assumed to be the sole role of abiotic and biotic processes. Most environmental toxicants pose minimal hazards simply because of their limited life span in the environment. Other chemical toxicants may resist degradative processes and persist in the environment for extreme long periods of time. Regular disposal of persistent chemicals into the environment can result in their accumulation to environmental levels sufficient to pose toxicity. Such chemicals can continue to pose hazards long after their disposal into the environment has ceased (Timbrell J.A., 2000). Both biotic and abiotic

processes contribute to biodegradation of chemicals.

In abiotic degradation, various categories of environmental forces alter the structural integrity of chemicals in the environment. Photolysis and hydrolysis are basically the abiotic processes that significantly effective in degradative processes.

Photolysis: this involves the effect of light mostly of ultraviolet range on chemicals, thereby breaking their chemical structures. It is dependent on the intensity of light and the capacity of the pollutant molecules to absorb the light. Energy from light has the capacity to facilitate the oxygenation of environmental contaminants via hydrolysis or oxidative processes.

Hydrolysis: this involves the dissociation of chemical bonds by water molecules in the presence of light. It involves the insertion of oxygen atom into the molecule with the commensurate loss of some components of the molecule. Hydrolytic rates of chemicals are influenced by the temperature and pH of the aqueous media.

Biotic degradation involves the active participation of microorganisms in degradative processes of environmental contaminants. Microorganisms (bacteria and fungi) degrade chemicals in an effort to extract energy from them. These biotic processes are enzyme-mediated and occur at rates that far exceed abiotic degradation. Biotic degradative processes can lead to complete mineralization of chemicals to water, carbon dioxide, and basic inorganic constituents. Biotic degradation employs some abiotic processes such as hydrolysis, oxidation, de-halogenation, ring cleavage and de-alkylation. The processes by which microorganisms are used to facilitate the removal of environmental contaminants are known as bioremediation.

### **FOOD TOXICOLOGY**

Food occupies a position of central importance in virtually all cultures, because most food cannot be commercially produced in a definable environment under strict quality controls. Food generally cannot meet the rigorous standards of chemical identity, purity, and good manufacturing practice. Food contains hundreds of thousands of substances, most of which have not been fully characterized or tested.

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The presumption that food is safe is based on a history of common use and that the consumption of certain foods is deeply rooted in tradition. Various substances in use affect the nutritional and aesthetic qualities of food, including appearance and organoleptic properties. These substances come in different forms like flavours, conferring texture or aroma. Whereas substances present in food may be nutritional and/or gratifying, they may not necessarily be “safe” in any amount or for any intended use. When the uncertainty about the risk of the added substance is small compared with the uncertainties attending food itself, the standard of “reasonable certainty of no harm” for the added substance has been satisfied (Curtis D., 2007).

**Safety evaluation of direct food and colour additives:** The basic concept that forms the foundation for the safety evaluation of direct food and colour additives is the recognition that the safety of any added substance to food must be established on the basis of the intended conditions of use in food. Factors that need to be taken into account include (1) the purpose for use of the substance, (2) the food to which the substance is added, (3) the concentration level used in the proposed foods, and (4) the population expected to consume the substance. Each additive can pose unique safety questions, depending on its chemistry, stability in use, metabolism, toxicity study results, and estimated human exposure.

### **FOOD-BORNE ILLNESSES**

Food-borne illness is any illness resulting from the consumption of contaminated food. There are two types of food poisoning: food *infection* and food *intoxication*. Food infection refers to the presence of bacteria or other microbes which infect the body after consumption. Food intoxication refers to the ingestion of toxins contained within the food, including bacterially produced exotoxins, which can happen even when the microbe that produced the toxin is no longer present or able to cause an infection. In spite of the common term 'food poisoning', most cases are caused by a variety of pathogenic bacteria, viruses, prions or parasites that contaminate food, rather than chemical or natural toxins (Wexler P., 2000).

Food-borne illness usually arises from improper handling, preparation, or food storage. Good hygiene practices before, during, and after food

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preparation can reduce the chances of contracting an illness. There is a general consensus in the public health community that regular hand-washing is one of the most effective defenses against the spread of food-borne illness. The act of monitoring food to ensure that it is wholesome and will not cause food-borne illness is known as food safety. Food-borne disease may be caused by a large variety of toxins/poisons abundant in our the environment.

Food-borne illness can also be caused by pesticides or medicines in food and naturally toxic substances like poisonous mushrooms or reef fish.

### **Symptoms and Mortality**

Symptoms typically begin several hours to several days after consumption and, depending on the agent involved, can include one or more of the following: nausea, abdominal pain, vomiting, diarrhea, gastroenteritis, fever, headache or fatigue.

In most cases, the body is able to permanently recover after a short period of acute discomfort and illness. However, food-borne illness can result in permanent health problems or even death, especially for people at high risk, including babies, young children, pregnant women (and their fetuses), elderly people, sick people and others with weak immune systems.

Food-borne illness, owing to campylobacter, yersinia, salmonella or *shigella* infection, is a major cause of reactive arthritis, which typically occurs 13 weeks after diarrheal illness. Similarly, people with liver disease are especially susceptible to infections from *Vibrio vulnificus*, which can be found in oysters or crabs.

Tetrodotoxin poisoning from reef fish and other animals manifests rapidly as numbness and shortness of breath, and is often fatal.

### **Incubation period**

The delay between consumption of contaminated food and appearance of the first symptoms of illness is called the incubation period. This ranges from hours to days (and rarely months or even years, such as in the case of Listeriosis or Creutzfeldt-Jacob disease), depending on the agent and on how much was consumed. If symptoms occur within 16 hours after consumption of the food, it is suggested that the illness is caused by a bacterial toxin or chemical rather than live bacteria. The long incubation period of many food-borne illnesses tends to cause sufferers to attribute

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their symptoms to "stomach flu".

During the incubation period, microbes pass through the stomach into the intestine, attach to the cells lining the intestinal walls, and begin to multiply there. Some types of microbes stay in the intestine, some produce a toxin that is absorbed into the bloodstream, and some can directly invade the deeper body tissues. The symptoms produced depend on the type of microbe.

### **Infectious dose**

The infectious dose is the amount of agent that must be consumed to give rise to symptoms of food-borne illness, and varies according to the agent and the consumer's age and overall health. In the case of Salmonella, Hodgson E. (2004) stated that relatively large inoculums of 1 million to 1 billion organisms are necessary to produce symptoms in healthy human volunteers, as Salmonellae are very sensitive to acid. An unusually high stomach pH level (low acidity) greatly reduces the number of bacteria required to cause symptoms by a factor of between 10 and 100.

### **Pathogenic agents**

#### **Bacteria**

Bacteria are common causes of food-borne illness. In the United Kingdom, during 2000, the individual bacteria involved were as follows: Campylobacter jejuni (77.3%), Salmonella (20.9%), Escherichia coli O157:H7 (1.4%), and all others less than 0.1%. In the past, bacterial infections were thought to be more prevalent because few places had the capability to test for norovirus and no active surveillance was being done for this particular agent. Symptoms for bacterial infections are delayed because the bacteria need time to multiply. They are usually not seen until 1272 hours or more after consumption of contaminated food.

Most common bacterial food-borne pathogens are these:

Campylobacter jejuni, which can lead to secondary Guillain-Barré syndrome and periodontitis;

Clostridium perfringens, the "cafeteria germ";

Salmonella spp. - its S. typhimurium infection is caused by consumption of eggs that are not adequately cooked or by other interactive human-animal pathogens;

Escherichia coli: enterohemorrhagic which causes hemolytic-uremic syndrome.

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Other common bacterial food-borne pathogens are as follows:

Bacillus cereus

Escherichia coli, other virulence properties, such as enteroinvasive, enteropathogenic, enterotoxigenic, enteroaggregative.

Listeria monocytogenes

Shigella spp.

Staphylococcus aureus

Streptococcus

Vibrio cholerae,

Vibrio parahaemolyticus

Vibrio vulnificus

Yersinia enterocolitica and Yersinia pseudotuberculosis

Less common bacterial agents:

Brucella spp.

Corynebacterium ulcerans

Coxiella burnetii or Q-fever

Plesiomonas shigelloides

### **Exotoxins**

In addition to disease caused by a direct bacterial infection, some food-borne illnesses are caused by exotoxins which are excreted by the cell as the bacterium grows. Exotoxins can produce illness even when the microbes that produced them have been killed. Symptoms typically appear after 16 hours, depending on the amount of toxin ingested.

Clostridium botulinum

Clostridium perfringens

Staphylococcus aureus

Bacillus cereus

For example, Staphylococcus aureus produces a toxin that causes intense vomiting. The rare but potentially deadly disease botulism occurs when the anaerobic bacterium Clostridium botulinum grows in improperly canned low-acid foods and produces botulin, a powerful paralytic toxin.

Pseudoalteromonas tetraodonis, certain species of Pseudomonas and Vibrio, and some other bacteria, produce the lethal tetrodotoxin, which is

present in the tissues of some living animal species rather than being a product of decomposition.

**TABLE 1: OTHER FOOD BORNE ILLNESS**

Illness	Causative agent	Main source of infection	Symptoms	Preventive measures
<i>Bacterial Illnesses</i>				
Streptococcal food poisoning	<i>Streptococcus faecalis</i>	Persons with sore throat, faecal contamination of hands and nasal discharges	Vomiting, diarrhea, abdominal pain	Pasteurization of milk; careful hand washing and hygiene; thorough cooking; prompt refrigeration.
Brucellosis	<i>Brucella abortus</i>	Contaminated milk	Irregular fever, sweating, headache, sore throat	Use pasteurized milk
Campylobacter Infection	<i>Campylobacter jejuni</i> or <i>C. coli</i>	Cross-contamination, farm animals and birds, contaminated water, undercooked poultry.	Fever diarrhea, abdominal pain	Avoid cross-contamination; thorough cooking; prompt refrigeration, no pets allowed in kitchen.
Listeriosis	<i>Listeria monocytogenes</i>	Milk and meat of infected animals; susceptible foods which are refrigerated, like soft cheese, salads, sausages.	Miscarriages and still births in pregnant women, meningitis and septicemia in infants	Avoid refrigerated foods that are likely to be contaminated and cannot be heated; thoroughly heat cook, chill meals, use pasteurized milk.
<i>Viral Illnesses</i>				
Influenza	Influenza virus	Direct contact, droplet infection, infected articles, contaminated food and utensils.	Fever, headache, cold, sore throat, respiratory infection, muscular pain and weakness	Sick food handlers should be kept away from kitchen and service areas
<i>Parasitic Illnesses</i>				
Tape worm infestation	<i>Taenia solium</i> and <i>Taenia saginata</i>	Raw or insufficiently cooked diseased pork or beef containing cysts	Malaise, digestive disorder, abdominal pain, hungry feeling, vague discomfort	Cook pork and beef thoroughly; purchase only from licensed shop
Roundworm Infestation				

a) Ascariasis	<i>Ascaris lumbricoides</i>	Contaminated food that contains eggs of this parasite, contaminated soil and water	Worms infest small intestine, abdominal pain, pneumonia	Personal hygiene, thorough hand washing
b) Threadworm infestation	Pinworms or threadworms ( <i>Enterobius vermicularis</i> )	Dirty finger nails harboring eggs of the parasite, clothing, soil and sewage contaminated foods	Infest upper part of large intestine, cause itching and swelling near the anus when adult worm lays eggs	Trim finger nails; wash hands after touching unsanitary parts; remove all soil from vegetables.
Giardiasis	<i>Giardia intestinalis</i>	Cysts are transmitted through contaminated food and water	Abdominal cramps, distension and tenderness, fatty diarrhoea	Use potable water; wash hands thoroughly after using the toilet and before handling food

\* Although it is an air-borne infection, it can be transmitted through food also; hence, it is included here

**Source: Roday, 2010**

**TABLE 2: FOOD BORNE ILLNESSES AT A GLANCE**

<i>Bacterial Food Poisonings or Intoxications</i>	
1. <i>Staphylococcus</i> food intoxication	3. <i>Bacillus cereus</i> food poisoning
2. <i>Botulism</i>	4. <i>Perfringens</i> food poisoning
<i>Bacterial Food Infections</i>	
1. Salmonellosis	6. Campylobacter infection
2. Typhoid and paratyphoid	7. Streptococcal infection
3. Bacillary dysentery	8. Brucellosis
4. Cholera	9. Listeriosis
5. Enteropathogenic infection	
<i>Viral Infections</i>	
1. Infectious hepatitis	2. Influenza
<i>Parasitic Infestations</i>	
1. Amebiasis	4. Giardiasis
2. Trichinosis	5. Roundworm infestation
3. Tapeworm infestation	
<i>Naturally occurring toxicants in Foods</i>	
1. Lathyrus sativus	5. Cereals and Groundnuts
2. Soybeans	6. Poisonous mushrooms
3. Green Potatoes	7. Mussels and clams
4. Argemone oil	8. Ergot
<i>Toxic Metals and Chemicals</i>	
1. Selenium	8. Tin
2. Zinc	9. Brass
3. Arsenic	10. Fluoride
4. Lead	11. Barium
5. Cadmium	12. Mercury
6. Cobalt	13. Pesticides
7. Copper	
<i>Food Allergies</i>	
1. Eggs	3. Chocolates
2. Shellfish	4. Strawberries

Source: Roday, 2010

**TABLE 3: NATURAL TOXIC SUBSTANCES IN FOOD**

S/No	Toxin	Food in which it is present	Main symptoms	Preventive measures
1.	BOAA ( $\beta$ -oxalyl amino-L-alanine)	<i>Kesari dal</i> or <i>Lathyrus sativus</i> used as an adulterant in <i>tivar dal</i>	Lathyrism- paralysis of lower limbs	Steep or parboil <i>dal</i> before use; ban the crop.
2.	Trypsin inhibitor	Soybeans	Indigestion	Heat treatment to inactivate the inhibitor; use processed soy products.
3.	Solanine	Green Potatoes	Abdominal pain, vomiting and diarrhea	Discard green, damaged or sprouting potatoes
4.	Mycotoxin	Ergot Fungus, Infected Cereals	Ergotism	Control moisture level in grains to prevent mould growth
5.	Sanguinarine	Argemone oil used as an adulterant in mustard oil	Epidemic dropsy	Purchase oil from reliable suppliers
6.	Aflatoxin	Mouldy peanuts and grains	Liver damage	Dry grains well; store at appropriate temperature.
7.	Muscarin	Poisonous Mushrooms of <i>Amanita sp.</i> Like <i>Amanita muscaria</i>	Affects the nerves; liver damage	Purchase mushrooms or spawn for cultivation from recognized outlets.
8.	PSP-Paralytic Shellfish Poison (an alkaloid)	Ocean mussels and clams	Itching, numbness of lips, muscular weakness and paralysis	Avoid seafood at certain periods of the year e.g. during red tide, toxins is heat stable

Source: Roday, 2010

**TABLE 4: TOXIC EFFECTS OF SOME METALS AND CHEMICALS**

S/No	Substance	Foods commonly involved	Toxic effect
1.	Selenium	Food grains and fodder from excessive selenium in soil	Gastro-intestinal disturbances, stunted growth
2.	Zinc	Acidic foods stored in galvanized iron utensils	Dizziness, vomiting, anemia
3.	Arsenic	Fruits sprayed with pesticides containing lead arsenate	Cutaneous lesions, lung cancer
4.	Lead	Drinking water, some processed foods	Paralysis, brain damage
5.	Cadmium	Fruit juices and soft drinks in contact with cadmium plated vessels	Excessive salivation, liver and kidney damage
6.	Cobalt	Water, beer	Cardiac failure
7.	Copper	Acid foods in contact with tarnished copperware	Abdominal pain, vomiting, diarrhea
8.	Tin	Canned food left in the opened can	Headache, diarrhea, vomiting, metallic taste in the mouth
9.	Brass	Acidic foods cooked in utensil which are not tin-plated	Astringent taste in the mouth, vomiting
10.	Fluoride	Water with high levels of fluorine	Skeletal and dental fluorosis
11.	Barium	Foods contaminated with rat poison	Violent peristalsis, abdominal pain, vomiting and diarrhea, paralysis
12.	Mercury	Seed grains treated with mercury fungicide	Paralysis, brain damage
13.	Pesticides	Any type of food	Damage to liver, kidney, brain and nerves; can lead to death
14.	Monosodium-glutamate or Ajinomoto	Chinese food, especially soups, fast foods, gravies	Headache, burning and tingling in arms and neck.

Source: Roday, 2010

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### **METAL TOXICITY**

Metals are very important materials in the environment owing to their toxic potential to man. The use of metal, especially iron, can be dated as far back as when man began his existence on earth, but its manifestation as a toxic material started being obvious with the progress from Stone Age into the technologically advanced age.

The first observation of metal toxicity was observed in the ninth century, in central Italy, when Iron was discovered. A man extracting metals was observed with an abdominal colic. In modern times, we have seen the increase of the usage of metals in sophisticated products so as to meet the demand of the increasing world population which in effect has led to the exposure of many people to these metals, either directly or indirectly. Direct metal toxicity occurs when the human is exposed directly to the metal itself -- for example, an industrial worker who is exposed to lead. Indirect toxicity occurs when the exposure is via environmental pollution of air, water, soil, and a host of others from the dumping of waste products from the metals.

Most metals do not have an instant effect on the human body but continue to accumulate until they become very harmful to the system, though some are essential to man at a low concentration. The use of a chelating agent in the treatment of toxicity is becoming very useful to man. (Chelating agents, as substances, are used to clear any specific metal they could grab). The only way to control the spread and effects of metal toxicity in our society or workplaces is to replace these harmful metals with metals that are less harmful; though it may be difficult to do, it is one of the best chances. Also, if the standard of exposure to these metals could be reviewed regularly, it will help to reduce the level of toxicity of metals in human.

Exposure to most of these metals is either beneficial or harmful, depending on the dosage level. Low dosage could be essential, but high dosage can cause toxicity or malignancy. The long latency period of most of these metal has made it difficult to diagnose early. Epidemiological studies and findings are always difficult to come by because of the considerable distance of most industrial workers from their factories which are the basic source of contamination; and when illness develops after some years, the patient might possibly die from malignancy, and no

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one can trace the cause of death. There are ample opportunities for research into all aspects of toxicology and carcinogenesis of metal and an epidemiological studies would be most welcomed.

### **LEAD**

The major source of exposure to lead is through contaminated food and water, though paints and other sources like mining, and smelting sites could also be sources, the greatest is exposure to food. The rate of exposure and retention of lead is higher in children than in adults. Lead is also a major source of air pollution, that is, via lead found in gasoline used by motor vehicles.

Lead is found majorly in the bones in the human body; it has a half life of 20 years or more. In children, it is found concentrated around the epiphyses. It is then slowly turned over from the bone and released in the blood stream where it can remain for years after exposure. Lead does not have a long half life in soft tissues (20 to 30 days). It has also been observed that lead passes into the placenta and, thus, infects unborn infants and fetuses. Its manifestations in human include gastrointestinal, hematological, central and peripheral nervous systems.

### **BERYLLIUM**

The effect of Beryllium exposure is of a long-term accumulation which is usually stored in fibrotic nodules. It has been experimentally proven that beryllium when inhaled, clears from the body in about 2 weeks, but some of the remainder, will be slowly removed and fixes itself in the fibrotic granulomatous nodules, particularly in the lungs. Ingested beryllium is absorbed only in acidic media like the stomach. It is deposited in the liver, spleen and bone marrows; but the majority ends up in the bones. It has a short half life, except in the lungs.

Beryllium is excreted in urine where it could be measured and estimated. Its effects on humans are majorly seen on the skin and the lungs. Contact dermatitis is common, especially from soluble products. Insoluble products cause chronic granulomatous lesions with ulceration and tissue necrosis. Embedded insoluble materials result in lesions that will not heal until it is removed.

Lung lesions is characterized with acute effects, chronic granulomatous

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lesions (berylliosis) and carcinoma. Just like other metals, beryllium has a long latency period between the exposure and pathological manifestation.

- i. In acute effects, there is a violent inflammatory process involving all levels of the respiratory tracts from the nasal region to the alveoli.
- ii. Dyspnea and Cyanosis are typical symptoms of Berylliosis.
- iii. Lung malignancy
- iv. Decreases the fidelity of DNA synthesis, though not a mutagen, in the bacterial system.

### **ALUMINUM**

Aluminum is the third most abundant element in the world, after hydrogen and Oxygen. It constitutes 8% of the earth crust and is found basically as ore mixed with other substances. It is very reactive. The major sources of aluminum in the environment are from dust, from ores and rock materials in the earth surface, volcanic eruptions, but the principal source is bauxite ( $Al_2O_3 \cdot H_2O$ ). Aluminum is also a constituent of acid Rain. It is also a product of combustion of many fuels and also gaseous effluents of trash to steam plants, and also the smelting of some large metals like aluminum, nickel and chromium. Aluminum from exhausts of gasoline-driven automobiles is a major air pollutant.

Aluminum exposure in human is inevitable since it is present everywhere -- in the air, water, soil and in food, through the use of aluminum in food packaging, processing and preserving. Aluminum is used in anti-perspirants and cosmetics, as well as in antacids. Aluminum is used in making cooking utensils, and it is believed that the more the utensils are used, the more the amount of Aluminum released.

Presently, it is believed that intakes of aluminum have to be considerable before it can cause harm to humans. Though long term low level exposure has not been understood -- whether it causes any harmful effect. Aluminum accumulates principally in bones and in the lungs; blood concentration never seems to be high.

- i. It forms a complex with pectin in the gastrointestinal tract which seems to affect absorption of other substances.
- ii. Aluminum has a positive effect in that it diminishes cholesterol absorption, but its significance is offset by some negative

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- features such as binding with phosphorus which leads to osteomalacia which causes lowering of phosphorus levels. Calcium and folate absorption are also affected.
- iii. The study of various forms of dementia and other related neurological disorders have shown positive effects of aluminum levels in the various organs and tissues.
  - iv. Though not proven, it has been shown that a high level of aluminum is found in patients suffering from Alzheimer's disease.
  - v. Dialysis Dementia is also observed in patients on long-term dialysis for chronic renal disease. It is manifested by speech disorder which progress to dementia convulsion and death. Increased aluminum levels have been found in the muscles, bones and brain.

### **MERCURY**

Mercury is found in fossil fuels (approximately 1ppm). Mercury from the combustion of fossil fuels, mercury vapour in the air, and mercury released from the earth crust sense constitute a significant source of atmospheric mercury. This mercury in the air mixes frequently with other gases to form acid rain which contaminates surface water. Also, mercury is gotten from exposure to herbicides and germicides which contaminates soil and ground water and may be metabolized by certain grains. Fish ingest biota and could be eaten by humans.

There are three forms of mercury -- elemental ( $Hg_0$ ), organic and inorganic ( $Hg_1$ ,  $Hg_2$ ). Mercury is one of the metal that is toxic to humans in its elemental form. It could be inhaled as vapour; and it affects the respiratory tracts, and crosses into the blood stream. Mercury is lipid soluble and attacks red blood cells. It is toxic to the central nervous system. Organic mercury occurs in two forms important to humans, and these forms are methyl and ethyl-mercury. They are toxic to man, also soluble in lipid and can pass through membranes readily. Mercury, especially the elemental mercury, forms a covalent bond with sulphur, and this bond is viewed as one of the properties of the metal to its biological and poisonous effects.

#### **All forms of mercury are highly toxic**

Chronic mercury poisoning is owned to the gastrointestinal uptake of

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$\text{Hg}^{2+}$  and it affects the kidneys. Chronic mercury poisoning, owing to inhalation, affects the central nervous system (CNS). The difference in the effect of the same element appears owing to the fact that the lipid soluble  $\text{Hg}^0$  is transported via the blood to the brain, where it is oxidized.

- i. Organic mercury (methyl-mercury), which is an important organic toxic agent, damages the brain and so manifestation is largely neurologic.
- ii. Metallic mercury affects the cardiovascular system in humans.
- iii. Gastrointestinal effects described in the form of cramps, diarrhea and other minor symptoms have been observed.
- iv. Hematological and hepatic effects have also been recorded.
- v. Mercury is oxidized to divalent mercury from its elemental forms when the tissue has been absorbed. It is transformed in the liver, secreted in the bile, reabsorbed by the gastrointestinal tracts and excreted by the kidneys.
- vi. Mercury affects all tissue of the body, but it most affects the central and peripheral nervous systems and the kidneys.
- vii. Various forms of behaviour and other symptoms are involved in the brain, and they are...
  - Tremors
  - Irritability
  - Forgetfulness
- viii. Mercury ingestion or inhalation is very toxic in humans and could lead to neurosis and involvement of neurons, which, in turn, could lead to cerebral atrophy.

### ARSENIC

Arsenic manifests in different forms, especially in trivalent and pentavalent forms in nature. Inorganic compounds such as pentoxide, arsenic acid and various salts (such as arsenate of lead and calcium) are examples of pentavalent forms; those of trivalent forms include trioxide and trichloride and sodium arsenite, too. The major occupational risk for arsenic is in facilities of herbicides and insecticides manufacture. The base used in this preparation is usually arsenic trioxide ( $\text{As}_2\text{O}_3$ ). Arsenic can also be contacted in zinc, copper and lead smelting industries, where they are released into the air. Arsenic is widespread in nature and is found in food in the pentavalent nature. It is found in water from the air

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effluents from industries and herbicides and pesticides that contaminate ground water. Ubiquitous arsenic is usually pentavalent; the forms that contaminate the environment are usually trivalent, and they are usually toxic. Trivalent arsenic is recognized as a carcinogen for lung cancer and skin cancer, too.

Arsenic is usually excreted from the body via the urine, it also appears in the sweat of an individual's desquamated skin, and hair. The hair is usually used as a specimen for investigating arsenic contamination in humans. Arsenic could also penetrate the placenta, and be seen in tissue of fetuses and new born infants. Arsenic was formerly used for treating skin rashes and cancer until it was found to cause cancer itself.

- i. Arsenic has been proven to cause arsenic poisoning and squamous cell carcinomas of the respiratory tract, mostly affecting the lungs. Latrogenic exposure to arsenic has been observed to cause skin and lung cancer, and cases of malignancy of other organs have been observed, too, especially in the liver.
- ii. When arsenic combines with hydrogen, it forms arsine, which is a gas. It is a hemolytic agent, and exposed humans have the following symptoms:
  - iii. Dyspnea
  - iv. Vomiting
  - v. Nausea
  - vi. Blood hemolysis
  - vii. Death occurs in renal failure and hemoglobinuria.
  - viii. In non fatal cases, persistent anemia and jaundice occur.

### **NICKEL**

Nickel occurs naturally in ore with iron or copper. During its smelting, potentially dangerous air pollutants like nickel compounds are released, and these are extremely potent toxins and carcinogens ( for example, nickel carbon). Nickel is also an air pollutant, in most cities, from the exhausts of gasoline engine and combustion of fossil fuel. It is also present in cigarette smoke. Nickel has no human physiological role, except the fact that it is toxic and helps in the development of malignant tumors. The production and usage of nickel is very dangerous; therefore, those exposed to it in workplaces should be protected with either clothing gloves and masks and, if possible, have urine tests weekly to monitor the

nickel level in them.

The common presentation may include the following:

- i. Skin irritation
- ii. Skin rashes
- iii. Asthma-like attacks
- iv. Skin changes have also been observed in people wearing nickel containing jewelry.
- v. Nickel is widely and dangerously distributed by the sintering and noasting of nickel sub-sulfide and nickel oxide together with nickel dust and metallic particles.
- vi. Most nickel compounds are carcinogens of lung cancer, gastric carcinoma and soft tissue sarcomas. It is believed that the nickel carcinogens have a long latency period between exposure and appearance of the tumors.
- vii. The presence of nickel in cigarette smoke has also been proven to cause lung cancer when it is inhaled (nickel carbonyl is the nickel present in cigarette smoke).
- viii. Nickel carbonyl has been observed to be lipid soluble, thereby allowing it to pass across cell membranes without any metabolic change.

### **CHROMIUM**

The major source of exposure to chromium occurs whenever an individual lives close to chromium manufacturing plants or where chromates are used. The major use of chromium is for steel and stainless steel, cement production and production of painting, plants, pigment and leather finings. A considerable amount of chromium pollutes the air around the areas where those products are generated. Waste water and its solid waste are as well very dangerous. Chromium III and VI are important in some bodily functions. For instance, chromium III improves glucose utilization and tolerance in diabetics and malnourished people, while chromium VI is essential for glucose and lipid metabolism. Chromium VI is toxic to the body and is recognized as a carcinogen when humans are exposed to it.

Generally, chromium is associated with respiratory tract irritation when inhaled.

- i. It is characterized with nasal septal irritation followed by nasal

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- ii. and palatal bone erosion.
  - ii. General change in its irritant nature leads to nonspecific inflammation throughout the upper respiratory tract.
  - iii. Chromium poisoning causes dental caries and alveolar disease.
  - iv. Recent findings show that there is an increase in lung markings and hilar lymph node enlargement before the manifestation of pulmonary carcinoma in exposed patients. It has been designated a form of pneumoconiosis called chromitosis.
  - v. The lung is also considered as the reservoir for the metal. From there the metal is released after exposure.
  - vi. It has a long latency period between exposure and lung cancer, making it an epidemiological problem.
  - vii. Long-term following of workers in chromate factories would be the best available means of epidemiological and pathological studies to identify its cumulative nature in the body.

#### **EFFECTS OF CHEMICAL SUBSTANCES ON MAN**

It is well known that occupational and environmental exposure to toxic materials is very detrimental to human health. The development of malignancies in human has been attributed to environmental influences. A subset is attributed to exposure to direct occupational exposure taking cognizance of the level of exposure and carcinogenic risk. Environmental influences are mostly attributed to the life styles of individuals, personal habits, culture and, sometimes, diet. Regardless of these estimations, it is clear that environmental and occupational exposure to chemical toxins are responsible for inducing a variety of acute and chronic pathological alterations and death in humans. This paper intends to look at the important classes of chemicals that have been designated as potential causes of human diseases from environmental exposure in non-occupational and occupational settings, providing some information on the mechanisms of agents and response to these agents.

#### **POLYCYCLIC AROMATIC HYDROCARBONS**

Polycyclic aromatic hydrocarbons (PAHs) are groups of chemicals that are ubiquitous in the environment. They occur naturally or could be man-made. They are insoluble in water and slightly soluble in ethanol. There are about 100 different PAHs in existence, and each has varied pathophysiological consequences.

- i. PAHs are commonly formed in the combustion of organic materials like wood, coal, gasoline and other fuels present in industrial materials like coal tar, coke tar, asphalt and creosote.
- ii. PAHs are released into the environment through industrial activities, especially in production of coal tar, asphalt and coke and also the catalyzed cracking of petroleum. Emissions from exhausts of gasoline and diesel engines are major means of urban resident exposure.
- iii. They can be gotten from cigarette smoking and the use of outdoor grills and the burning of wood in fire place.
- iv. Low levels of PAHs are primarily gotten in the population from the inhaling of cigarette smoke, wood smoke, and ingestion of contaminated food.
- v. PAHs naturally occur in food. Some foods that show these traits of PAHs are smoked, barbecued and charcoal broiled foods, sea food, meat, vegetables and vegetable oil and also roasted coffee. The ingestion of these foods is the only source of PAHs in non smokers.
- vi. Occupational exposure occurs to those who work in coal tar production plants, foundries, road and tarring operations, asphalt production plants and smoke houses where carbonaceous materials are combusted. The highest level of exposure is found among these occupational groups.

#### **VINYL-CHLORIDE (C<sub>2</sub>H<sub>3</sub>CL)**

This is a colourless vapour with a mild sweet odor. It is a major constituent of plastic production. Vinyl-chloride is potentially exposure to human in occupational sites, although it has been detected in the air around hazardous waste sites and landfills near plastics production facilities. The primary route of exposure is by inhalation, even though dermal exposure exists for plastic workers. Inhalation results in rapid spread of vinyl-chloride throughout the body.

- i. Vinyl-chloride is metabolized by mammalian tissue. The primary pathway for this metabolism appears to be oxidation involving cytochrome P-450-dependent. This results in formation of highly reactive intermediate metabolite, 2-chloroethylene oxide, which binds covalently to cellular macromolecules, including DNA and RNA.

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- ii. Vinyl-chloride has been observed to cause pathologic alterations in humans, especially induction of malignancies in multiple organ sites.
  - iii. It has also been observed that chronically exposed workers to vinyl- chloride suffered from hepatic angiosarcoma, confining that vinyl-chloride is a carcinogen.

### **BENZENE (C<sub>6</sub>H<sub>6</sub>)**

Benzene is an industrial chemical used as an additive in gasoline, solvents for inks, oil and paints, and also in the manufacture of some types of rubber, lubricants, dyes, detergents, drugs and pesticides. It is a raw material for styrene production in the plastic industry. Exposure to benzene occurs both occupationally and non-occupationally. All benzene emitted to the environment is in the air and, therefore, most exposure to benzene by humans is via inhalation.

- i. Outdoor sources of benzene exposure include automobile exhausts and industrial emissions. Cigarette smoking is also an important source of benzene emissions since it is released from the combustion of tobacco.
- ii. It was demonstrated that benzene toxicity was dependent upon hepatic metabolism.
- iii. The initial oxidative metabolism result of benzene is the formation of an epoxide, benzene oxide with reaction with cytochrome P45011E, which also metabolizes alcohol and aniline
- iv. Benzene metabolites can form covalent bonds with DNA and RNA. This has shown the covalent binding of benzene metabolites to DNA and inhibition of RNA synthesis in liver and bone marrow mitochondria.
- v. Benzene (occupational exposure) has been associated with toxic damage of the hematopoietic system and development of leukemia.
- vi. Both aplastic anemia and pancytopenia have been associated with benzene exposure. (A plastic anemia is a disorder in which all cellular elements of the blood and bone marrows are depleted).
- vii. It has also been shown to be genotoxic in humans, causing primary chromosomal, aberrations in humans, with peripheral

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lymphocyte and bone marrow cells as main targets.

### **BENZIDINE**

This is a crystalline solid with significant vapour pressure. It is the major raw material in the production of azo dyes. It is a potential chemical carcinogen.

- i. Owing to its carcinogenic properties, Benzidine has been limited to closed systems with stringent environmental controls.
- ii. Exposure to benzidine is via exposure to different azo dyes and from the release of dyes from industrial sources as waste products in the form of water discharges, sludges and solid wastes.
- iii. It is estimated that the carcinogenicity risk of benzidine is 14 times higher in workers of benzidine dyes than for the general population.
- iv. Carcinogenicity of benzidine is related to its metabolism and its patterns of binding to DNA.
- V. Benzidine is a carcinogen in humans and is related to urinary bladder cancer. This has been known since the 1890s.

### **FORMALDEHYDE**

This is a colourless flammable gas that contains methanol as a polymerization inhibitor and is sold in aqueous solution. It is also marketed in solid forms as triozame and paraformaldehyde. It is used in production of urea-formaldehyde resins and phenol-formaldehyde resins. Formaldehyde is a major constituent of disinfectants, fumigants, room deodorizers, seed treatment, preservatives and tissue hardener and corrosion inhibitors in metal industries. The primary risk exposure is for those who use formaldehyde in production of products and workers in garment, printing and publishing industries.

A major source of formaldehyde in the air is from automobile exhausts.

- Formaldehyde is rapidly metabolized by the human system after exposure.
- It is usually oxidized to formic acid in a reaction that can be catalyzed by several systems.
- Exposure to formaldehyde produces irritation in the eyes and skin. It is also a sensitizing agent.
- It induces DNA-protein cross-linking and DNA single strand

- breaks in human cells.
- Formaldehyde is actually confirmed to be a weak carcinogen in humans but high exposure should be minimized.

### **CARBON DISULFIDE**

Carbon disulfide (CS<sub>2</sub>) is a highly refractive and flammable liquid that has a sweet (pure) and foul (commercial) odor. It is highly soluble in organic solvents and slightly soluble in water. It was used in the vulcanization of rubber in the early nineteenth century. It is used as a raw material in carbon tetrachloride, pesticides and a host of chemical productions. Carbon disulfide emanates from some biogenic sources, including volcanic eruption.

The primary route of human exposure is via the inhalation of carbon disulfide. Percutaneous absorption is also a potential route for occupational exposure. Carbon disulfide could be excreted via the exhalation by the lungs and kidneys through urine. These are usually not metabolized carbon disulfide. Metabolism of carbon disulfide occurs in two ways. Formation of dithiocarbamates and glutathione conjugate and Oxidize mediated generation of sulfur which binds covalently to macromolecules.

Cardiovascular toxicity has long been associated with the occupational exposure to carbon disulfide.

- i. There have also been cases of neurological, gastrointestinal, renal, hepatic, reproductive and ophthalmological toxicity in humans.
- ii. Carbon disulfide is a major cause of coronary heart disease in exposed workers.
- iii. There are exposure-related effects in the autonomic nervous system.
- iv. Behavioural abnormalities have also been associated with acute carbon disulfide exposure, including extreme irritability, uncontrolled anger and a toxic manic-depressive psychosis.
- v. The primary concern of carbon disulfide is still cardiovascular toxicity.

### **BIS(CHLOROMETHYL) ETHER AND CHLOROMETHYL ETHER**

Bis(chloromethyl) ether (BCME: C<sub>2</sub>H<sub>4</sub>OCH<sub>2</sub>CL) is a colourless, volatile

liquid with a suffocating odor. It is water-soluble and is rapidly decomposed to hydrogen chloride and formaldehyde. Chloromethyl-methyl ether (CHE;  $\text{ClCH}_2\text{OCH}_3$ ) is a volatile corrosive liquid usually containing BCME as a contaminant. They are used in the synthesis of plastics and manufacture of ion exchange resins. Exposure to BCME and CME is primarily by inhalation, dermal contacts, and general population, because it rapidly decomposes in water. CME and BCME are reactive alkylating agents and are not activated by metabolism. Pure CME is a weak carcinogen, while BCME is a potent carcinogen. Occupational exposure to CME-BCME is associated with lung cancer, especially cell carcinoma. Development of cancer of the lung is associated with duration and cumulative exposure to CME-BCME. The latency period for development of lung cancer by CME-BCME is short in exposed workers.

#### **HALOGENATED HYDROCARBONS**

These are products of industrialization and do not occur in the natural environment. They are mostly used in agricultural and industrial settings. They usually are not degradable and therefore continue to accumulate and pose environmental hazards. Although the kidneys and liver seem to be their targets, there is no known human effect yet. The carcinogenic potentials of most of the chemicals in this class are mediated by nongenotoxic mechanisms, some of which are related to tissue injury and compensatory cell regeneration subsequent to the toxic injury.

#### **TETRA-CHLORO-ETHYLENE (PERCHLORO-ETHYLENE)**

Tetra-chloro-ethylene ( $\text{C}_2\text{Cl}_4$ ) is a lipid-soluble, colourless liquid used in the dry-cleaning and textile processing industries. It is also used as an industrial solvent, an intermediate in production of some fluorocarbons, an insulating fluid and cooling gas in electrical transformers. It is detectable in urban areas and in ground and surface and drinking water in rural areas.  $\text{C}_2\text{Cl}_4$  is exposed to humans in work places, while non-occupational exposure is via dry cleaners Laundromats. The primary route of exposure for humans to  $\text{C}_2\text{Cl}_4$  is via inhalation and dermal contacts (even though absorption through the skin is minimal). It can also be ingested. The carcinogenicity of  $\text{C}_2\text{Cl}_4$  in humans is not very clear; malignancies in humans have been associated with high

environmental exposure to  $C_2Cl_4$  Tetra-chloro-ethylene has been found to be carcinogenic in other mammals.

### **CHLOROFORM ( $CHCl_3$ )**

This is a clear, colourless, volatile liquid. It is non-flammable but, upon contact with flame, can decompose to form hydrochloric acid, phosgene and chlorine.

- The primary use for chloroform is in the production of fluorocarbons. It is also used as solvent for many products and compounds.
- Chloroform was formerly used as anesthetic but was discontinued.
- Chloroform exposure occurs occupationally and non-occupationally. Workers are exposed via inhalation, dermal absorption and on ingestion. The general population is exposed through drinking water or by inhalation of contaminated air.
- It is enzymatically metabolized by cytochrome P-450-dependent mixed-function oxidizes in mammals.
- The initial oxidative hydroxylation of chloroform produces trichloromethanal (an unstable and spontaneously dechlorinate) to produce  $COCl_2$ , the metabolite is electrophilic and readily forms covalent bonds with cellular macromolecules.
- Chloroform is a hepatic and renal toxic in rats and mice.
- It causes enlargement of liver, hepatotoxicity and kidney damage in humans, and is especially more fatal in alcoholics than in those who are not.
- It is a weak mutagen.

### **CONCEPT OF DISEASE CONTROL AND PREVENTION**

Disease is defined as a definite morbid process or a deviation from normal human physiology, having a characteristic train of signs and symptoms. It is also an abnormal condition affecting the body of an organism (man). It may be caused by external factors, such pathogenic parasites or microorganisms, or it may be caused by internal dysfunctions, such as autoimmune disease. In humans, disease is often used more broadly to refer to any condition that causes pain, dysfunction, distress, social problems, and/or death to the person

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afflicted, or similar problems for those in contact with the person. In this broader sense, it sometimes includes injuries, disabilities, disorders, syndromes, infections. Isolated symptoms, deviant behaviours, and atypical variations of structures and functions, while in other contexts and for other purposes these may be considered distinguishable categories. Diseases usually affect people not only physically, but also emotionally, as contracting and living with many diseases can alter a person's perspective on life, and his or her personality. There are four main types of disease: pathogenic disease, deficiency disease, hereditary disease, and physiological disease. All these groups, or classes, of diseases are largely influenced by the environment -- physical, social or psycho-social, biological, chemical, etc. in which one lives or works.

There are two main classes of disease- communicable/ infectious and non- communicable diseases. Disease may affect the whole body or parts of the body. It's etiology, pathology; prognosis may be known or unknown. It also defined as any departure from normal health. It may be congenital (that is, being present from birth or acquired) or degenerative (that is, when the tissue regress, often seen in older people).

Disease prevention is the trust of Environmental Public Health which focuses on the prevention of disease, both in individuals and communities.

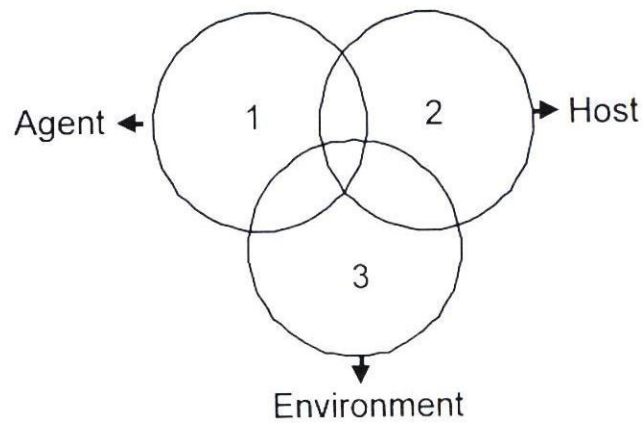
### **AGENT-HOST-ENVIRONMENT RELATIONSHIPS IN DISEASE CAUSATION**

The series of events that lead to the transmission of diseases involve the **agent**, **host** and **environment**, each playing specific roles. The connectivity or links between these three factors form the "epidemiological triangle or triad" also described as the "chain of infection or transmission" (Sanders *et al* 2010).

In the process of disease transmission the agent interacts with the host (Man), while the environment influences what happens between the two. Acknowledgment of this relationship is therefore necessary for proper

understanding of the natural history of disease for adequate prevention and control.

### EPIDEMIOLOGICAL TRIAD OR UNIMODAL CAUSATION



**Fig. 12: Agent Host and Environment Interactions**

*Source: Adapted from Sarders et al 2010; CDC 2009; Lucas & Gills 2004)*

Each of the three factors (agent, host, and environment) shown above, has certain characteristics which are significant to the maintenance of the relationship for disease transmission. These are briefly summarized as follows:

A description of these is necessary for proper understanding of the basic roles in disease transmission process.

#### 1. AGENT

The agent is the first link in the chain of disease transmission. It is defined as a substance (living and non-living), the excessive presence or relative lack of which may initiate or perpetuate a disease process.

Disease may be caused by a single agent or a number of independent alternative agents or combination of two or more agents whose presence is a necessary factor to cause disease.

## TYPES OF AGENTS

Disease agents are classified into six different groups:

- i) **Biological** or living agents e.g. bacteria, viruses, fungi, protozoan, rickettsiae etc.
- ii) **Nutrient agents:** e.g. proteins, fats, carbohydrates, vitamins, minerals. Deficiency or excessive amount in any of these may result to illness or nutritional disorders; such as protein energy malnutrition (PEM), marasmus, anaemia, goiter, obesity etc.
- iii) **Physical agents:** e.g. heat, cold, humidity, pressure, radiation, noise. Exposure to these could cause disease.
- iv) **Chemical agent:** These are of two types: Endogenous and exogenous chemicals:
  - i. Endogenous agents are chemical toxins formed in the body which can cause abnormality in physiological functions such as urea (ureamia), serum bilirubin (jaundice), ketones (ketosis), calcium carbonates (kidney stones) etc.
  - ii. Exogenous agents are undesirable substances found in the environment outside the body. They constitute hazards to human health when exposed e.g. dust, fumes, gases, insecticides, allergens etc.
- v) **Mechanical agents:** These are physical forces (frictional and mechanical) that cause injury and death through tearing, crushing, sprain and lubrication.
- vi) **Social agents:** These include poverty, smoking, drug abuse, alcoholism, unhealthy life style, stigmatization, social isolation etc.
- vii) **Deficiency or Excess** of intrinsic factors that promote health e.g.
  - iii. Hormonal factors e.g. insulin, oestrogen, enzymes.
  - iv. Nutritional factors e.g. obesity, PEM, anaemia
  - v. Lack of structure, e.g. Thymus
  - vi. Lack of structural components e.g. cardiac defects.
  - vii. Hereditary factors e.g. chromosomal abnormality, such as mongolism, turners syndrome.
  - Viii. Immunological factors e.g. gamma globulimia (Park 2007; CDC 1998).

### Characteristics of the agent

- ix. Inherent factors: Physical features, biological requirement, chemical composition, liability, resistance.
- x. Those directly related to man e.g. infectivity, virulence, pathogenicity, antigenicity
- xi. Those related to the environment e.g. reservoir, and sources of infection and circle of transmission.

### Agent characteristics related to man

- i) **Infectivity:** This is the ability of the agent to gain entry and adapt to the host so it can get metabolic support for development and survival.
- ii) **Virulence:** This is defined as the severity or degree of the reaction caused by the agent in the host, usually measured in terms of fatality.
- iii) **Antigenicity:** Is the ability of the agent to stimulate a response in the host body.

### Agent reactions or pathogenetic mechanisms

The reactions which the agent induces in the host body include:

- xii. Direct tissue invasion
- xiii. Production of a toxin (poisonous chemicals)
- xiv. Immunologic enhancement or allergic reaction leading to damage to the host
- xv. Persistence or latent infection
- xvi. Enhancement of host susceptibility to drugs of otherwise minimal toxicity.
- xvii. Immune suppression (Park 2007, Sander, Adarsh and Pankaj 2010, Muthu 2005, CDC 1998).
- xviii.

## 2. HOST

The host forms the third link in the chain of disease transmission and is defined as a person or animal that provides metabolic support to an infectious agent to enable it grow and multiply under natural conditions. The reservoir and source of infection are synonymous with the host. The reservoir refers to man, animals, insects, plants, soil or inanimate objects

or substances or any combination of these in which the disease agent lives and multiplies in such a way as to aid its transmission to a susceptible host. The source is a person, thing, object or substances from which an infections agent immediately passes to a susceptible host. (Sanders, Adarsh & Pankaj 2010, Muthu 2005, Park 2007).

**TABLE COMMON SOURCES OF INFECTION, AND RESERVOIRS**

Disease	Reservoirs	Sources
Malaria	Man Mosquito	Parasitized
Cholera	Man	Water food
Typhoid	Man	Water food
Tuberculosis	Man	Sputum
Whooping cough (pertusis)	Man	Droplet spray or aerosols
Tetanus	Seil	Soil

Source: Sandars *et al* 2010)

### Important Host Factors Associated with Disease Transmission

The factors in the host that enhance disease transmission include age, sex, marital status, host nutritional and immune status occupation, life style, habits. But not all of these are of equal risk. The entry of infections agent in the host body triggers certain reactions and defense mechanism to fight against the agent. The entire pathway or process is below:

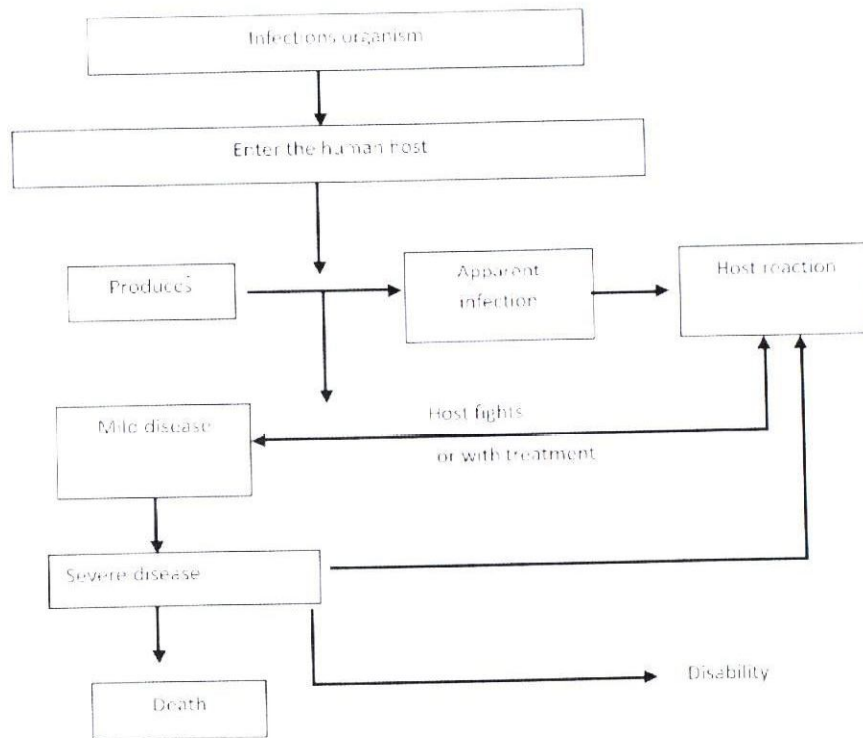


Fig 13 : Host Reactions

### CONCEPT OF DISEASE CAUSATION

What causes disease could be epidemiologically defined as a characteristic, behaviour, exposure, condition, circumstance, event or combination of these factors that influence disease occurrence in man. There are two varieties of causative factors that produce disease known as "necessary cause" and "sufficient cause". Necessary cause refers to a

specific etiologic agent which is very essential for disease to occur, such as *Vibrio cholerae* in a cholera outbreak. In this case *Vibrio cholerae* is the etiologic agent, and in its absence, cholera does not occur. Hence, it is termed the necessary cause of the disease. Sufficient cause(s) may be regarded as those factors in the environment and factors / conditions in the host, other than the etiologic agent which produce a disease provoking stimulus or stimuli for initiating the disease process in the host. For instance, during cholera outbreaks, not all individuals who drink contaminated water become sick. Many remain well even after taking the water containing the pathogen (*Vibrio cholerae*). This shows *Vibrio cholerae* is not the sufficient cause of cholera, although it is a necessary cause. Thus, sufficient cause for cholerae comprises several factors such as poor excreta disposal, water contamination, adequate dose of *Vibrio cholerae*, survival of the organism, host factors (resistance, immunity, nutritional status etc).

The concept of disease occurrence can also be regarded as a direct causal association between two variables which Park (2007) refers to as "one-to-one causal relationship". This model states that two variables 'A' and 'B' are said to be causally related if a change in one (A) results to a change in the other (B). Where, this does not happen, then their relationship is not causal. Thus, it implies that when factor 'A' is present, the disease 'B' must occur. Also, when the disease is present, the factor must be present. In other words, there must be a necessary cause and sufficient cause(s) for disease to occur. The above model corresponds with Koch's germ theory of disease which requires that for a causative factor to qualify as cause of disease, it must be:

- (a) necessary and
- (b) sufficient for the occurrence of disease.

Nevertheless, this concept is only relevant and applicable to communicable diseases. It does not fit into non-communicable diseases with single cause or factor / multiple cause or factors (Park 2007; CDC 2009).

### **MODELS OF DISEASE CAUSATION**

A model is a simplified representation that helps to explain complex natural phenomena. Therefore various models have been developed by

epidemiologists to facilitate the understanding of the process of disease occurrence in man reported by CDC 2009, and Emeharole 1996. The models include:

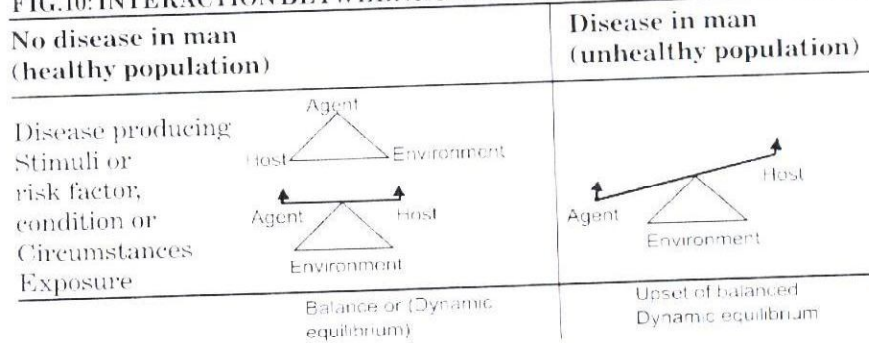
- Ecological model or Epidemiologic triad
- Social ecological model or Causal pies
- World Health Organization Model
- Holistic model
- High-level wellness model

Among the models listed above, the epidemiologic triad or triangle or ecological model referred to as unifactorial model and social ecological model or causal pies also known as multifactorial model are the simplest and most popular:

### 1. UNIFACTORIAL MODEL OR EPIDEMIOLOGIC TRIAD

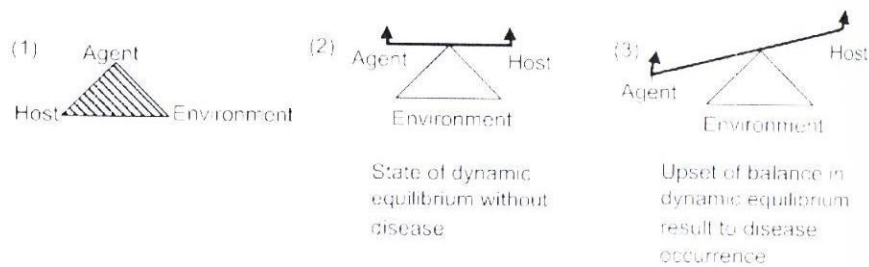
The unifactorial model is the oldest concept used to explain disease occurrence based on the germ theory of disease introduced by Robert Koch since the early period of epidemiologic development. It is a traditional model that describes the process of transmission of communicable disease to man, popularly called epidemiologic triad or triangle. The triangle which comprises an agent, host and environment depicts the complex manner or ways in which the three factors interact to produce disease in man. The agent requires a susceptible host for metabolic support and a suitable environment to facilitate transmission from source to the host. Below is an illustration of the epidemiologic triad or triangle.

**FIG.10: INTERACTION BETWEEN AGENT HOST AND ENVIRONMENT**



*Source: Adapted from CDC 2009 and Emeharole 1996.*

Furthermore, Emeharole 1990 explains that when the agent, host and environment are in a state of dynamic equilibrium under normal condition, disease may not occur and man remains healthy. But if there is an imbalance or upset in the continuum, as a result of environmental changes (pollution), increase in the agent ability to infect man (host), or increase in the number of susceptible hosts in the population etc. then disease occurs. Different diseases require different balances and interaction between the agent, host and environment.



**Fig 14: Epidemiological Triangle or Ecological model**

*Source: Adapted from CDC 2009; Sauder & Parakej 2010; Park 2007; Emeharole 1996 and Mathu, 2008.*

#### **AGENT:**

Agent is defined as the causative factor responsible for disease occurrence. The term was formally limited to infectious microorganisms or pathogens such as bacteria, virus, parasites, but the concept has been extended to include chemical and physical factors capable of causing disease or injury. Thus, the epidemiologic triad which hitherto served as a useful model for many diseases cannot be applied to chronic diseases and other health problems that have multiple causes or factors contributing to their occurrence or development.

#### **HOST:**

Refers to a person who can be infected by disease. Various factors in the host body can influence the individual exposure, and susceptibility or response to a causative agent. Other factors that play significant roles include behaviour (e.g. personal hygiene, unprotected sex, smoking etc.).

age and sex characteristics of the host. Susceptibility and response to an agent are both caused by factors such as genetic make-up, immunity, nutritional status, anatomy / physiology, health status, and psychological characteristics.

#### ENVIRONMENT:

Refers to extrinsic factors that can affect the agent and individual exposure which include:

1. Physical factors e.g. geology, climate
2. Biological factors e.g. insect vectors that transmit the agent
3. Chemical factors e.g. toxic chemicals and pollutants / contaminants.
4. Socio-economic factors e.g. overcrowding, poor sanitation, available of health services etc. (CDC 2009).

#### 1. MULTIFACTORIAL MODEL OR CAUSAL PIES

The multifactorial model known as Causal pies was proposed by Rothman in 1976 when it became apparent that the agent-host-environment or unifactorial model could no longer clarify the multifactorial nature of disease causation. The causal pie is made up of component causes that represent individual factors contributing to disease occurrence. Each individual factor is called a piece of a pie and all the pieces of a pie put together forms the complete pie also termed 'Causal Pathway' or "Sufficient Cause" because without it disease cannot occur.

The illustration below shows how the causal pie model works.

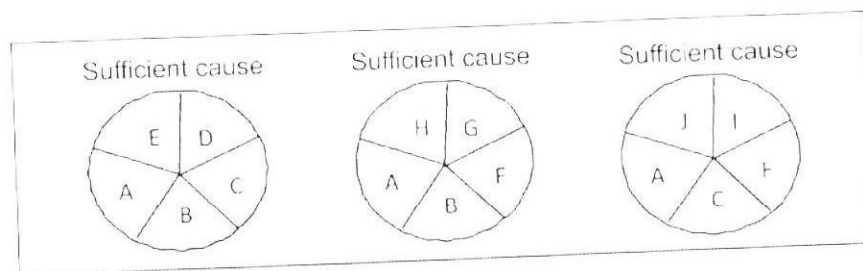


Fig 15: Component causes and causal pies model  
Source: Rothmans K.J 1976 and CDC 2009

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According to the model, a disease usually has more than one sufficient cause each comprising several component causes that may or may not overlap. The component which appears in every pie is a necessary cause and disease can not occur without it. The above illustration indicates that A' is a necessary cause because it appears in all the pies.

The component causes include both intrinsic host factors and agent, as well as environmental factors of the agent-host-environment triad. It therefore follows that no single component is a sufficient cause by itself to produce disease, just as an infectious measles virus may not result in measles disease. Similarly, *Pneumonyctie carinii* considered as normal flora of the respiratory tract is harmless in healthy persons, but may cause severe pneumonia in HIV positive individuals whose immune systems have been weakened by the virus. Presence of the pathogen (*Pneumonyctie carinii*) alone is therefore a necessary cause, but not sufficient cause of pneumonia.

The model further implies that disease is caused by a combination of different sufficient causes or pathways, as in lung cancer that may result from sufficient causes like smoking, asbestos and other factors outside smoking or asbestos. (CDC 2009).

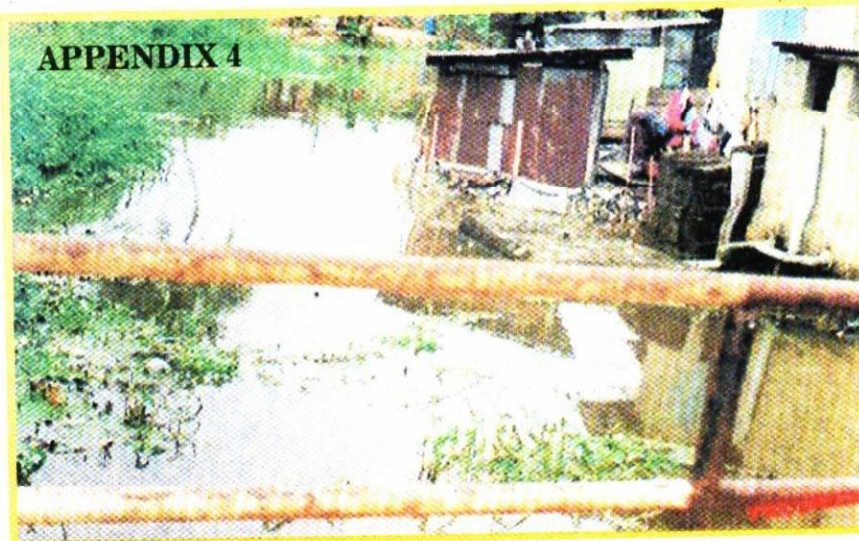
A simple way to illustrate the multifactorial (multiple causation) model is to use the case of a pedestrian hit by a car and was taken to hospital where he died. In the course of investigation and autopsy the pathologist revealed that the cause of death was due to slow diagnosis in the emergency room, the chemist attributed the cause of death to shock, the investigating police blamed the death on the excessive speed by the driver, while the driver claimed the pedestrian was intoxicated and reacted improperly. In all the diagnosis stated above, each of the arguments has some merit in the cause of death. This explains exactly what the multiply causation or multifactorial model of disease occurrence is all about. It implies that each factor could have been the cause of death of the pedestrian. Conversely, if prompt action was taken to prevent the accident, death could have been averted. The lesson from this incident is that just as there are several opportunities to prevent death, several possibilities also exist to interrupt the continuity of disease transmission (U.S. Army Medical Dept.)

### APPENDIX 3



*Fig 3: Showing an insanitary waste dump along a major road in Enugu State. This may facilitate the breeding of disease vector. All forms of refuse are dumped together.*

### APPENDIX 4



*Fig 4 showing polluted water body in Yenagoa Bayelsa State. The water is also used for domestic purposes. The activities above may increase water borne/related diseases.*