COURSEWARE ON HISTORY AND PHILOSOPHY OF SCIENCE

Edited-by:

Professor Abdus-Salam, N.
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We appreciate the efforts of past coordinators, Profs. M.T. Yakubu and N. Abdus-Salam in the review of old editions; and the current coordinator, Dr. (Mrs.) A.M.O. Abdul Raheem (First Female Coordinator in the GNS Division) for assisting in the gathering, assessment and editing of the manuscript for a comprehensive 2017 review and 2019 Courseware Production.

We are also grateful to all the past directors, both dead and living, who have contributed to the birth of the book in the first instance and successive review of the old editions.

Our appreciation will not be complete without mentioning the efforts of Directors of COMSIT, Prof. M.O Yusuf and CODL, Prof. H. Owolabi who facilitated the training on formulation of the courseware development, the knowledge of which we believe turned this book to a resource and instructional material for the benefit of our students. We appreciate the Director, CODL and his team for scripts editing in line with best practice.

Lastly, we appreciate all, who have contributed one way or another to the success of this FIRST edition of Courseware as a part of instructional materials for e-teaching and learning of GNS 311 .

Professor N. Abdus-Salam
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PREFACE

Knowing one of the objectives of GNS, a course for undergraduate students in the University is "To assist the students to develop and expand awareness of their social, cultural and physical environment, which invariably will prepare them to be effective in the Society" The general aim of the GNS 311, is "To introduce students to the broad area of the sciences and to create awareness about the value of the sciences and the effect of science on the human society" , the GNS Division of the University decides to make the teaching and learning of the contents of the book meet its aims and objectives and to become a resource and instructional material to the benefit of the students.

On assumption of duty as Director of General Studies Division in October, 2018 and as an active player in GNS division, I resolved to move the division to the next level in course contents writing and course delivery. This goal was achieved as the first edition of a full courseware on History and Philosophy of Science is now presented for use.

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August, 2019

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ABRIDGED COURSEWARE

Course: GNS 311 – History and Philosophy of Science (2 credits, 30h (T); R)

Duration: 2 hour per week for 15 weeks, (30 hours) Theory

Developer (s) : [1]N.Abdus-Salam, [2]A.M.O. Abdul Raheem, R. G. Jimoh, A.L. Quadri, O.K. Yusuff, A.A. Rajee, A.A. Lateef, R.M.O. Kayode, D.O. Opaleke, K. Iheme, M.M. Orosun, O.K. Bello, A.W. Banjoko, A.G. Akintola, O. O. Adeoye, A.A. Alfred, O.I. Alli & R.N. Ahmed
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Consultation Hours: 12 noon – 2 pm (Monday)

Course Content
Scientific methods, Scientific revolution and methodology, African physical environment. Agriculture in Nigeria. Man and the universe: origin, nature and cosmic environment. Concept of disease. Parasites and diseases. Use and abuse of human body. Concept of matter. Energy: sources, generation, distribution, inter-conversion and conservation. Threat and implication of nuclear war. Science and technology in the society and service of man. Relevance of scientific research and advances in human society. Ethics and technology. Environmental effects of chemicals, plastics, textiles and wastes. Environmental sanitation. Chemical and radio-chemical hazards.

Course Description
Introduction of students to the meaning, history, philosophy of science and application of diverse fields of science to human society using normal classroom and e-learning methodology.

Course Justification
Better-by-far University graduates cannot be oblivious of the place of science in today's world. To have more than a pedestrian understanding of the key terminologies and evolution of the ubiquitous science and its tremendous impact in human society, a multidisciplinary perspective of the course by scientists from various backgrounds becomes imperative.

Course Goals
The main goals of this course are to introduce students to the broad area of the sciences and to create awareness about the value of the sciences and the effect of science on the human society.

Course Requirements
In addition to satisfying all requirements specified in the course, Students must participate in all assignments either individual or group. To this end, all students are required to activate their e-mail accounts as Continuous assessment will be carried out ubiquitously. PC-Tab and internet access are compulsorily required.

Methods of Grading

S/No.	Grading System	Score (%)
1.	Test (CBT)	20
2.	Real/Electronic Assignment (both, 5 marks each)	5
3.	Participation in assignment-online discussion	5
4	Final Examinations (CBT)	70
	TOTAL	**100**

The course delivery strategies for lectures will be real/virtual. An assignment/online discussion will be available to all students that registered for the course to exchange ideas.

TABLE OF CONTENTS

Module One

THE STRUCTURE OF SCIENCE, SCIENTIFIC METHODS AND REVOLUTION

Abimbola, I.O.
Department of Science Education ,University of Ilorin, Ilorin, Nigeria

INTRODUCTION

All disciplines have their structures with the structure of science cutting across all disciplines known by name. Understanding science structure, especially through its components, adds values to different category of individuals. Similarly, understanding the structure of science avails people to become scientifically literate and apply such knowledge into their life so as to identify the functions and limitations of science as a discipline. In sciences, major developments in the 17th century characterize it as a century of geniuses, century of scientific revolution and societies.

This chapter considers the history of the development of the scientific method by prominent scientists. Also considered was description of the life and achievements of the century's geniuses as well as the early scientific societies or academies.

LEARNING OUTCOMES

By the end of this module, you should be able to:

(i) define science
(ii) describe the components of the structure, products, processes and the ethics of science;
(iii) discuss the functions and limitations of science;
(iv) identify the characterizations of the 17th Century and describe the history of the two major forms of scientific methods as well as life histories and achievements of the major scientists of the 17th Century;
(v) discuss the relevance of the three characterizations of the 17th Century based on the major events of the Century;
(vi) describe the organization and the roles of the major early scientific societies or academies during the scientific revolution and in the contemporary world;
(vii) list four major scientific societies or academies in Nigeria.

MAIN BODY

Introduction

The module introduces you into the nitty-gritty of structure of science, scientific methods and revolution. This module is divided into four units as follows:

Unit 1 Concept of science

Subunit 1 Definition of Science
Subunit 2 Values of Science
Unit 2 Components of the structure of science
Subunit 1 Science products
Subunit 2 Science processes
Subunit 3 Science ethics
Unit 3 Functions of science
Subunit 1 Limitations of Science
Unit 4 History of scientific methods
Subunit 1 A century of geniuses
Subunit 2 Organisation of scientific societies

UNIT 1: DEFINITION OF SCIENCE

Contents

1.0 Introduction

This study unit introduces you to the definition as a discipline. The unit will focus particularly on the controversial nature and conceptions of the definition of science and the understanding of the structure of science, especially through knowledge of the components of the structure of science, add significant values to scientist, nonscientists as well as science teachers.

2.0 Learning Outcomes

By the end of this unit, you should be able to:

i. define science as a discipline;
ii. discuss the views about the nature and conceptions about science as a discipline
iii. identify group of people that can be influenced by values of the structure of science; and
iv. discuss the extent of influence of values of the structure of science in learning processes.

3.0 Main Content

3.1 What is science?

Generally, we can define science as a body of knowledge, a way of investigating or method, and a way of thinking in the pursuit of an understanding of nature. We can therefore view science as a noun, a verb, and as an adjective. We can define science with its products: Knowledge in the form of concepts, facts, generalizations, principles or rules or laws, and theories, subject to error and change. We can define science with its processes or methods or skills: how scientific knowledge comes about. We can also define science with its motives, or ethics or attitudes that guide the day-to-day activities of scientists. Selecting any of these aspects to define science would be inadequate and misleading.

3.2 General Conceptions About Science

Definitions of science vary slightly from scientist to scientist and from one subject area to another. Some people still describe science as an ordered body of knowledge while others define it as a search for explanations to natural objects and phenomena. We can consider science at present as an enterprise in which human beings participate to study and give parsimonious explanations of the materials and forces of nature. Science employs a variety of techniques. It has as its motive a desire to know. It assumes orderliness in nature. Understandable and acceptable ethical principles govern the activities of scientists. Science ends with credible concepts in the form of theoretical, empirical and rational constructs. We should take science as a human enterprise, the consequences of which have human implications.

3.3 What are the values of the structure of science?

Knowing the structure of science has its value. Science students and all those interested in the subject will know the components of the discipline and they will be able to relate to the discipline in a conscious manner so that during the learning processes, they will know what they are learning. The knowledge of the structure of science will also enable them to know how they can become scientifically literate persons through a judicious combination of knowledge and application of the components of the structure of science. Also, science teachers will understand what they are teaching their students better if they understand the structure of their subject matter. This knowledge will assist them in knowing how to properly organize science content for instruction. Evaluation of students' learning outcome will be enhanced through this knowledge.

4.0 Summary

Since it becomes quite difficult to concisely and precisely define science by an individual or group of individuals, thus an adequate definition of science needs to include all the three components of the structure of science. These three components include, science products such as concepts, facts, laws and theories; science processes, and the ethics of science that include, attributes that characterize scientifically literate persons. It is important for all and sundry (scientists and non-scientists) to understand the structure of science which thus

exposes them to values that can enhance their knowledge of science and avails them the opportunity of effective learning so as to satisfy their intellectual quest.

5.0 Self-Assessment Questions (SAQs)

i. define science as a discipline;
ii. discuss the views about the nature and conceptions about science as a discipline
iii. identify group of people that can be influenced by values of the structure of science;
iv. discuss the extent of influence of values of the structure of science in learning processes.

6.0 Tutor Marked Assessment

i. What is science?
ii. Describe, in detail, the basic components of the structure of science.
iii. "Concept difficulty can be measured in terms of the degrees of complexity, sophistication and abstractness of the concept." Explain what you understand by this statement using appropriate illustrations. What are the implications of the statement for the learning of science?
iv. Look up the following words from the dictionary and find out their meanings, derivations (origins), related idioms and synonyms: structure, science, product, process, ethics, concept, fact, law, theory, inferring, predicting, interpreting, hypotheses, experiment, objectivity, superstitions, dynamic, universal, and limitations.
v. Use the words in several sentences with your study partner until you have clearly understood them.
vi. State two differences between an empirical law and a theoretical law.
vii. Identify *three major* types of concepts. Give one example each from your major subject.

7.0 Further Reading

Abimbola, I. O. (1981), ***Discovery teaching and learning in science education: A critique based upon the conceptions of discovery held by philosophers of science.*** **Unpublished Master's Research Paper. University of Wisconsin**-Madison, Madison Wisconsin, U.S.A.

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UNIT 2 COMPONENTS OF THE STRUCTURE OF SCIENCE

Contents

1.0 Introduction

Components of the structure of science demonstrate what a scientifically literate person needs to possess for knowledge, skills, and attitudes. Thus, in this unit, you shall be examining the various forms of knowledge, methods and attributes of scientists to implement their day-to-day activities.

2.0 Learning Outcomes

At the end of this unit, you should be able to:

i. clearly identify the three components of the structure of science
ii. mention and give examples of the forms of knowledge as a product of science
iii. identify and differentiate between the types of concepts and laws as forms of knowledge
iv. list and explain various skills and methods in science
v. enumerate the attributes of a scientist and apply such in their life practices

3.0 Main Contents

3.1 Science Products

Products of science are the general outcomes of science as a discipline and this is collectively knowledge that takes the form of concepts, facts, generalizations, laws, and theories.

A concept is the meaning given to symbol or label and there are three types of concepts: Empirical concepts, theoretical concepts, and relational concepts.
Empirical concepts are concepts by inspection, concrete and observable concepts. Theoretical concepts are concepts by definition and are abstract and observable concepts. Examples include: molecule, absolute zero, gene, and so forth. Relational concepts are concepts that relate two or more concepts together and cannot exist on their own. Examples

include: less, more, equal, inverse, proportional, and so forth.

Fact: A fact is an event that occurred in the past that people recorded with no disagreement among observers but with or without disagreement in the future with chance of changes or revisions in observations.
Law: A scientific law or principle or rule or generalization is a brief statement or mathematical formula predicting inter-relationships among concepts. Scientific laws are not "broken" because they are not commands. It is not even necessary to break them. They are subject to modification and abandonment if scientists find them to be inaccurate. There are two types of laws; Empirical law and theoretical law. An empirical law is one that refers to observable concepts or concepts by inspection that does not provide explanation for the relationship it predicts. A theoretical law refers to theoretical concepts and provides explanation besides prediction.
Theory: A scientific theory is more advanced than a law. A theory combines several laws in its formulation. A classical definition of theory states it as a system of logical reasoning that scientists carefully construct to explain the unknown, based on valid assumptions about natural phenomena.

All theories must take, into account the known facts, however, scientists never prove theories true or false; they are only adequate or inadequate to explain a phenomenon. A theory serves as a basis for deducing empirical consequences from it. A theory is useful in explaining observed data. We can also use a theory to predict future events.

3.2 Science Processes

Processes of science are the methods and skills that scientists employ in their work. Processes of science are the scientific activity *per se*. Examples of science processes include the following: observing, classifying, inferring predicting, measuring, communicating, interpreting data, making operational definitions, formulating questions and hypotheses, experimenting, and formulating models.

3.3 Science Ethics

The ethical standards of the disciplines of the sciences guide the actions of the scientists. They are attributes of a scientifically literate person. They ethnical attributes that scientists are supposed to possess. They are also attributes that a person that is scientifically literate should show in his or her behaviors. Examples of ethical standards in science include the following but not limited to them: curiosity, open-mindedness, positive approach to failure, objectivity, respect for the opinion of others, willingness to suspend judgment, willingness to accept criticism, unwillingness to believe in superstitions, dynamism, cooperativity, anti-authoritarianism, morality, accuracy, orderliness and universality among others.

4.0 Summary

In this unit, we identified the three components of the structure of science as products (knowledge) which take different forms, science processes (skills and methods in science), as well as science ethics (attributes of scientists). Applying these components in our daily life

practice will make us better individuals.

5.0 Self-Assessment Questions (SAQs)

i. clearly identify the three components of the structure of science
ii. mention and give examples of the forms of knowledge as a product of science
iii. identify and differentiate between the types of concepts and laws as forms of knowledge
iv. list and explain various skills and methods in science
v. enumerate the attributes of a scientist and apply such in their life practices

6.0 Tutor Marked Assessment

i. describe, in detail, the basic components of the structure of science.
ii. "Concept difficulty can be measured in terms of the degrees of complexity, sophistication and abstractness of the concept."
explain what you understand by this statement using appropriate illustrations. What are the implications of the statement for the learning of science?
iii. what do you understand by "the structure of science"?

7.0 Further Reading

De Vancouleours, G. (1957). *Discovery of the universe.* New York: Macmillan.
Descartes, R. (1960). *Discourse on method and meditations* (L. J. Lafleur, Trans.). Indianapolis, Indiana: Bobbs-Merrill Educational Publishing Co.
Fraser, C. G. (1948). *The story of physics*. New York; Reinhold Corporation.
Hall, A. R. (1954). *The scientific revolution*, 1500-1800. Boston: Beacon Press.

UNIT 3 FUNCTIONS OF SCIENCE

Contents

1.0 Introduction

Science describes the world in form of qualities and attributes that human beings can understand using familiar descriptors such as numbers, shapes, sizes, weights and ratios. In

doing this, science thus perform different functions in our life. The method of science is only one of the methods of knowing that yields knowledge. Therefore, science is one kind of knowledge that human beings base decisions upon. Science is not everything thus characterized by a few shortcomings despite of its numerous advantages.

2.0 Learning Outcome

At the end of this unit, you should be able to:

i. Identify and describe various functions of science
ii. Identify and describe the limitations of science

3.0 Main Content

3.1 What are the functions of science?

Science as a discipline performs important functions in our individual and collective life. These functions include the following:

- Science describes the universe and relates us with it to create a niche for ourselves.
- It satisfies desires to know and gives us intellectual satisfaction.
- It enables us to predict consequences of our actions.
- It provides us with the achievements of the present and future.

3.2 What are the Limitations of Science

Science describes the world as adequately as possible. However, there are a few other aspects of life that science failed to adequately address. These are the limitations of science:

- It does not take decisions itself
- Its laws are not enforceable
- It can be inaccurate with its predictions
- It does not believe in miracles (final causes) and takes time to explain causes of unexpected outcomes.

4.0 Summary

Science as a discipline performs a lot of functions that are beneficial to humans. These functions are channeled toward bringing about development, avoidance of risks, knowledge enhancement to human. This unit has exposed students to various limitations of science which are important in concluding that science as a discipline is not everything.

4.0 Self-Assessment Questions (SAQs)

i. State two functions of science
ii. Enumerate the limitations of science

5.0 Tutor Marked Assessment

i. Identify and describe five scientific attitudes that characterize a scientifically literate person.
ii. State five functions of science
iii. Discuss the limitations of science

6.0 Further Reading

De Vancouleours, G. (1957). *Discovery of the universe.* New York: Macmillan.
Descartes, R. (1960). *Discourse on method and meditations* (L. J. Lafleur, Trans.). Indianapolis, Indiana: Bobbs-Merrill Educational Publishing Co.
Fraser, C. G. (1948). *The story of physics*. New York; Reinhold Corporation.
Hall, A. R. (1954). *The scientific revolution*, 1500-1800. Boston: Beacon Press.

UNIT 4 HISTORY OF SCIENTIFIC METHODS AND REVOLUTION

Contents

1.0 Introduction

The17th century is very significant in many respects. The many names by which we characterize the century attest to this significance. We characterize the century variously as the century of "The Scientific Revolution," "The Century of Genius," and "The Century of Scientific Societies." Here, the century of scientific revolution is important because it was in this century that various scientific methods were proposed by scientists thus resulting into the systemization and revolutionization of science from the old scientific practice to the modern one.

Also the works of notable scientists of the 17th century that are products of the scientific

revolution is discussed of which list includes great scientists such as: Galileo, Harvey and Newton etc. The formation of scientific societies was one of the most important developments of the 17th Century. These societies filled the vacuum left by the decline of early universities. There was a felt need to disseminate and exchange scientific information with like-minded colleagues, hence, the formation of these societies or academies.

2.0 Learning Outcomes

At the end of this unit, you are expected to:

i. identify the three characterizations of the 17th Century;
ii. describe the history of the two major forms of scientific methods.
iii. describe briefly, the life histories and achievements of the major scientists of the 17th Century.
iv. describe the organization and the roles of the major early scientific societies or academies during the scientific revolution;
v. discuss the roles of the early scientific societies or academies as the forerunners of scientific societies in the contemporary world;
vi. list major four major scientific societies or academies in Nigeria; and

3.0 Main Content

3.1 Describe the characteristics of the 17th century and history of scientific methods

The 17th century is characterized as the century of scientific revolution, geniuses and societies. This is owing to the activities that occurred during this period. Scientific methods were developed by Francis Bacon and Renes Descartes. Earlier scientists are interested in discoveries and inventions without emphasis on practice. At the time, philosopher describe what scientists do, the standard they follow and the standard their discoveries and inventions should meet. In the 17th century, the movement to study science by observation and experimentation became scientific revolution. It was the century that scientists pay attention to scientific methods. Westfall puts the date when experimental methods of modern science started to have influence on scientific communities as 1590.

Taylor noted Galileo Galilei as the first scientist to employ modern scientific method fully in Physics and Astronomy. Francis Bacon wrote a book on philosophy and methods of scientific investigation titled "*Novum Organum*" (meaning The new Insttrument). This book was in reaction to "*Organum*" written by Aristotle. Aristotle's was the old method of reasoning while Bacon's was new method of reasoning. Bacon was the first to formulate a series of steps to account for scientific methods in his book.
Steps accounting for scientific methods in Francis Bacon's *Novum Organum* include:

1. To collect reliable information
2. To classify information by tables
3. Arrival at generalisations (rules) and eventually scientific laws from the classifications

4. The new laws must identify new discovery about a phenomenon

These steps of scientific methods mark the landmark in systemization of science. Francis Bacon also proposed system for forming scientific organisations, the ideas adopted for the formulation of the Royal Society of London in 1660.

Descartes preferred mathematical reasoning and deduction rather than experimentation and deduction by Bacon. Bacon disregarded the role of mathematics in physical science while Descartes placed emphasis on mathematical reasoning about facts with little emphasis on observation. However, Isaac Newton succeeded in integrating the two opposing scientific methods by Bacon and Descartes.

3.2 History and achievements of scientists of the 17th century

The characterisation of the 17th century as a century of Scientific geniuses is as a result of the landmark achievements and histories of notable scientist during this period. Among these geniuses include: Galileo Galilei, Johannes Keppler, William Harvey and Isaac Newton.

1. Galileo Galilei

- He was the first to fully implement scientific method in Astronomy
- He invented the first thermometer (air thermometer)
- He mathematically studied motion of objects/bodies on earth
- He made large and more powerful telescope used to view the moon and planet

He made the following generalization through his observation:

- That the moon is not a smooth sphere shining on its light but with surface of mountains and craters that showed on reflected light
- That Jupiter has moons revolving around it
- That milky way is made of many stars
- That the sun was the centre of the solar system
- That the earth is not stationary but moves

2. Johannes Kepler (Laws of Planetary Motion)

- His work explained the motion of the planets around the sun
- Main work was the motion of Mars proving that the planets orbit the sun in elliptical path rather than circles
- He formulated the three laws of planetary motion which are still used in astronomy and planning the orbits of artificial satellites

3. William Harvey (Circulation of Blood)

- Before Harvey, heart was seen as seat for emotion and source of life
- Harvey showed that heart only pumps blood and keeps it in circulation through the body in a closed system of blood vessels
- He is regarded as the founder of physiology

4. Isaac Newton

- He merged the scientific methods of Bacon and Descartes
- He proposed the law of universal gravitation and laws of motion
- He invented calculus
- He described that beam of light has bands (spectra) of many colours
- He discovered reflecting telescope

3.3 Organisation and roles of scientific societies or academies

Earliest of these academies were formed in Rome in 1603 (i.e. Academia del Lincei) with Galileo Galilei a member of the academy. The members of the society were the first to use the microscope for scientific studies. The academy succeeded in coining the name Microscope. Academia del Lincei replaced Academia Secotorium Naturae founded in Naples and which was closed down for meddling with witchcraft.

The Royal Society of London the oldest association of scientists which grew out of a series of informal meetings called, "Invisible College" that was held in London and Oxford. The society started meeting formally in 1660. In 1662, King Charles 11 gave the society his seal of approval with the name "Royal Society for the Improvement of Natural Knowledge." The society served as a forum for presenting papers on topics of scientific interest and for presenting demonstrations and experiments. The Royal Society started publishing a journal the *Philosophical Transactions,* in 1665. In 1666, the French Academie Royale des Sciences (Royal Academy of Sciences) started its formal meetings in Paris. In 1662, it started to publish a journal. This society replaced an earlier one formed in 1654 under the auspices of Herbert de Montmor (1600-1679). It disbanded due to financial difficulties. The French King became interested in science and so the society became part of the Royal Court. The King paid the members of the society. The King also provided material support. The members of the society in turn carried out crown-supported research and became the inspectors of patents and the designers of new machines. There exists in Nigeria, Nigeria Academy of Science (NAS), Nigeria Academy of Letters (NAL) for Humanities professionals, and Nigeria Academy of Education (NAE) which are of interest to prospective scientists and teachers.

Most of the early and modern scientific societies published scientific periodicals that carried reports of the latest experiments, calculations, tables, and diagrams. They replaced the book as the basic means of transmitting current scientific information. The scientific societies also provided a forum for checking scientific discoveries and they established unwritten rules for scientific work. It is only fairly recently that the modern philosophers of science began emphasizing the important role the scientific community, through these societies, plays in providing appropriate checks and balances for the practice of science. However, space constraints in journals and time constraints in conferences do not seem to permit meaningful exchange of ideas as before.

4.0 Summary

This chapter therefore, traced the history of the scientific method as formulated by Francis Bacon and Rene Descartes and used gainfully by Galileo and Newton and other scientists of the century. The life history and the major contributions of the century's men of science such as Galileo, Kepler, Harvey, Newton and the organization of scientific societies in Italy, England, France and Nigeria are discussed. These societies or academies set the standard and the pace for the present-day scientific societies.

5.0 Self-Assessment Questions (SAQs)

i. Why do we refer to the 17th Century as the century of "the Scientific Revolution"?
ii. Justify the characterization of the 17th Century as "the Century of Genius."
iii Why is the 17th Century usually referred to as, “the Century of Scientific Societies”?
iv. Distinguish between the terms "Scientific Revolution" and "Industrial Revolution."
v. Name one major scientific achievement associated with each of the following great scientists: Galileo Galilei. Johannes Kepler. William Harvey and Isaac Newton.
vi. Name one early scientific society formed in each of the following countries: Italy, Britain, France, and Nigeria.
vii What eriod year(s), do we refer to as the 17th Century?

6.0 Tutor Marked Assessment

i. Why do we refer to the 17th Century as the century of "the Scientific Revolution"?
ii. Justify the characterization of the 17th Century as "the Century of Genius."
iii. Why is the 17th Century usually referred to as, “the Century of Scientific Societies”?
iv. Distinguish between the terms "Scientific Revolution" and "Industrial Revolution."
v. Why did Francis Bacon entitle his book, *Novum Organum* (New Instruments)?
vi. State the basic steps of Francis Bacon's scientific method.
vii. State the basic steps of Rene Descartes' scientific method.
viii. Name one major scientific achievement associated with each of the following great scientists: Galileo Galilei. Johannes Kepler. William Harvey and Isaac Newton.
ix. Name one early scientific society formed in each of the following countries: Italy, Britain, France, and Nigeria.
x. What period year(s), do we refer to as the 17th Century?

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Module Two

PHILOSOPHICAL PROBLEMS AND SCIENTIFIC EXPLANATIONS

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INTRODUCTION

What is science? Is there a real difference between science and myth? Is science objective? Can science explain everything? Provision of answers to this provides a concise overview of the main themes of this chapter which is philosophy of science.

LEARNING OUTCOMES

By the end of this module, you should be able to:

(i) account for the definitions of science;
(ii) itemise the 5 concepts of philosophy of science;
(iii) describe the methods for studying philosophical science;
(iv) give account of scientific explanation from the philosophical context;
(v) account for the models used for scientific explanations with specific examples and their shortcomings; and
(vi) explain the basis for the validity of scientific explanations and objectivity of observation in science.

MAIN BODY

Introduction

The module introduces you into the basics and definitions of philosophical sciences, scientific explanations, models and validity of scientific explanations in science.
Unit 1 Philosophy of Science
Unit 2 Scientific Explanations

Unit 1: Philosophy of Science

Contents

1.0 Introduction

In common usage, the word science is applied to a wide variety of disciplines or intellectual activities which have certain features in common. For philosophy to rightly take its place in the sciences, it must make a very significant contribution to the advancement of the subject matter as a consequence of knowledge.

2.0 Learning Outcomes

By the end of this module, you should be able to:

(i) account for the definitions of science;
(ii) explain the concept of philosophy of science;
(iii) describe the methods for studying philosophical science;

3.0 Main Contents

3.1 Definition is science?

Science

The word **science** is derived from the Latin word '*scientia'* meaning knowledge. Science can be defined in various ways. These definitions include:

- the state or fact of knowing; knowledge or cognizance of something specified or implied;
- a branch or study which is concerned either with a connected body of demonstrated truths or with observed facts systematically classified and more or less colligated by being brought under general laws and which include trustworthy methods for the discovery of new truth within its own domain;
- an ordered body of knowledge or a search for explanations to natural objects and phenomena; Such knowledge is derived from the systematic study of nature and behaviour of materials of the physical universe based on observations, experimentations, measurements and the formation of laws to describe these facts. These observed facts can be systematically classified and brought under general principles.
- devotion of man to research or to the attainment of the kind of knowledge which establishes general laws governing a number of particular isolated facts.

3.2 Philosophy of Science

Philosophy of science is concerned with the assumptions, foundations, methods and implications of science. For philosophy to rightly take its place in the sciences, it must make a very significant contribution to the advancement of the subject matter as a consequence of knowledge.
Philosophical science can simply be defined as critical discussion of the various

developments in science.
Philosophy of science has historically been met with mixed response from the scientific community. Though scientists often contribute to the field, many prominent scientists have felt that the practical effect on their work is limited as buttressed by a popular quote attributed to the physicist, Richard Feynman which states that "Philosophy of science is about as useful to scientists as ornithology is to birds."

3.2.1 Philosophy of particular sciences

In addition to addressing the general questions regarding science and induction, many philosophers of science are occupied with investigating philosophical or foundational problems in particular sciences. The late 20th and early 21st century witnessed an unprecedented rise in the number of practitioners of philosophy of a particular science such as philosophy of Biology, philosophy of Chemistry etc.

a. **Philosophy of Biology** deals with issues that focus on epistemology (study of theory of knowledge), metaphysics (study of reality) and ethics (study of norms of moral behaviour) contained in the biological and biomedical sciences.

b. **Philosophy of Chemistry** is concerned with the methodology and the underlying assumptions of the science of Chemistry. Specific topics of interest which are normally addressed include the relationship between chemical concepts and reality where resonance structures are used in chemical explanations, and the reality of concepts such as nucleophiles and electrophiles. Others include whether chemistry studies atoms or reaction processes, symmetry in chemistry specifically the homo-chirality in biological molecules and whether quantum mechanics can offer explanation to all chemical phenomena.

c. **Philosophy of Mathematics** focuses on the philosophical assumptions, foundations, and implications of mathematics. Topics of concern include but not limited to the sources of mathematical subject matter, what it means to refer to a mathematical object, character of a mathematical proposition, the relationship between logic and mathematics, the kinds of inquiry that play a role in mathematics, the objectives of mathematical inquiry, the source and nature of mathematical truth, and the relationship between the abstract world of mathematics and the material universe. Others include what is a number, why does it make a sense to ask whether "1+1=2" is actually true and how can it be ascertained that a mathematical proof is correct.

d. **Philosophy of Physics** can be viewed as the study of diverse concerns which include the fundamental aspects of physics, philosophical questions concerning modern physics, the study and interaction of matter and energy. The main questions concerning the nature of space, and time, atoms and atomism as well as the interpretations of quantum mechanics, predictions of cosmology, foundations of statistical mechanics, causality, determinisms and the nature of physical laws are addressed under this concept.

e. **Philosophy of psychology** deals with issues relating to theoretical foundations of modern psychology. Some of these however are addressed from the epistemological perspectives of the methodology of psychological investigation. Other concerns of philosophy of psychology include the philosophical questions about the nature of mind, brain, and cognition, and are perhaps more commonly thought of as part of cognitive science or philosophy of mind.

3.3 Method Used in Studying Philosophical Science

Three different methods can be used to render science accessible to people and to actually make it an object for philosophical scrutiny. The methods are: The pedestrian method; The Critical method; Original Philosophical method

(a) **The Pedestrian Method**
This method discusses topics in science. Such topics may include magnetism, electromagnetism, sub-atomic particles, enzymes, free radicals etc.

(b) **The Critical Method**
This involves taking up science and examining its fundamental assumptions and presuppositions, its competing theories, its method of inquiry and its relation or otherwise to other fields of study.

(c) **The Original Philosophical Method**
This method involves a trained philosopher injecting his *apriori* metaphysical, epistemological or ethical notions into science with the aim of uplifting its empirical content to the standard of it being adjudged the universal truth.

4.0 Summary

The word science is applied to a wide variety of disciplines or intellectual activities which have certain features in common. Studying the philosophical aspect of science will enable one to be accustomed with the development in science over the years; this will stimulate an active interest in the discipline. The methods used in studying the philosophical sciences are, the pedestrian method, the Critical method and Original Philosophical method.

5.0 Self-Assessment Questions

i. State three definitions of science;
ii. List any 5 philosophy of science;
iii. Describe 3 methods for studying philosophical sciences

6.0 Tutor Marked Assessment

1. Explain the philosophy of chemistry
2. Write short notes on the methods for studying philosophical sciences

7.0 Further Reading

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UNIT 2: SCIENTIFIC EXPLANATION

Contents

1.0 Introduction

Of the three cardinal aims of science, explanation is of the greatest. Scientific explanation aims at understanding science. The models used in scientific explanations and the basis for the validity is also explained in this unit.

2.0 Learning Outcomes

By the end of this module, you should be able to:

i. give scientific explanation from philosophical context;
ii. explain at least two models of scientific explanations;
iii. give at least an example each for scientific models; and
iv. explain the basis for the validity of scientific explanations.

3.0 Main Contents

3.1 Scientific Explanation

The three cardinal aims of science are prediction, control, and explanation; but the greatest of

these is explanation. Scientific explanation aims at understanding science.

Philosophical Context

The concept of scientific explanation is very important in philosophy of science because of several reasons:

Most people and scientists intuitively believe that one of the goals of the science is to explain the phenomena in the world. Some people even believe that explanation is the main goal of science.
Scientific realists use the "inference of best explanation" (IBE) principle to solve the strong under-determination problem and this way to prove that science can create true knowledge even about non-observable (non-empirical) entities.".
In addition to predicting future events, scientists more often than not use scientific theories to explain the events that occur regularly or have already occurred. Philosophers have investigated the criteria by which a scientific theory can be said to have successfully explained a phenomenon, as well as what gives a scientific theory credibility or explanatory power.
Several models have been put forward to back up the explanatory power of scientific theories.

3.2 Models for Scientific Explanation

i. Deductive-Nomological Model or D-N Account

One early and influential theory of scientific explanation was put forward by Carl G. Hempel and Paul Oppenheim in 1948. Their model of explanation, Deductive-Nomological (D-N), says that a scientific explanation succeeds by subsuming a phenomenon under a general law.

They proposed simply to describe what kind of things scientists tendered when they claimed to have an explanation, without asking whether such things were capable of providing "true understanding".

Shortcomings of the D-N Account

- The first kind of objection, points to the D-N theory's inability to account for judgments of explanatory relevance.
- The second important objection to the D-N account is the insufficient attention to the explanatory role of causal relations.
- The third class of objection to the D-N account focuses on the requirements that every explanation cite a law, and that (except in probabilistic explanation) the law or laws be strong enough to entail, given appropriate boundary conditions, the explanandum.

ii. Inductive-Statistical Model or IS Account

IS explanation is a law-involving argument giving good reason to expect that the explanandum event occurred. However, whereas a D-N explanation is a deductive argument entailing the explanandum, an IS explanation is an inductive argument conferring high probability on the explanandum.

Shortcomings of the IS Account

The important criticism of this model includes:

- There is too much to ask that explanations confer high probability on their explananda.
- A second objection to the IS account focuses on the requirement of maximal specificity.

iii. Statistical Relevance Model

Statistical relevance is presented as an objective relation, that is, a relation holding independently of the explainer's background knowledge or other context. Statistical relevance is a comparative concept.

3.3 Basis for the Validity of Scientific Explanations

Empirical verification

Science relies on evidence to validate its theories and models, and the predictions implied by those theories and models should be in agreement with observation. Observations should be repeatable, for example, experiments that generate relevant observations can be (and, if important, usually will be) done again. Furthermore, predictions should be specific and scientists should be able to describe a possible observation that would falsify a theory or a model that implies the prediction. Nevertheless, while the basic concept of empirical verification is simple, in practice, there are difficulties as described in the following sections:

Induction

How is it that scientists can state, for example, that Newton's Third Law of Motion (to every action, there is equal and opposite forces) is universally true? After all, it is not possible to have tested every incidence of an action, and found a reaction. There have, of course, been several tests, and in each one a corresponding reaction has been found. But is it sure that future tests will continue to support this conclusion?

One solution to this problem is to rely on the notion of induction. Inductive reasoning maintains that if a situation holds in all *observed* cases, then the situation holds in *all* cases. So, after completing a series of experiments that support the Third Law, and in the absence of any evidence to the contrary, one is justified to imply that the Law will hold in all cases.

3.4 Objectivity of Observations in Science

It is very important for science that the information about the surrounding world and the objects of study are as accurate and reliable as possible. For the sake of this, measurements which are the source of this information must be as objective as possible.
To further abstract from unreliable human senses and make measurements more objective, science uses measuring devices such as spectrometers, voltmeters, interferometers, thermocouples, counters), and more recently, the computers.
The less the human involvement in the measuring process, the more accurate and reliable the scientific data is.

Currently, most measurements are done by a variety of mechanical and electronic sensors directly linked to computers which further reduces the chance of human error/contamination of information.

Another question about the objectivity of observations relates to the so called experimenters regress, problems identified from the sociology of scientific knowledge, the cognitive and social biases of the people that interpret the observations or experiments which unconsciously interpret and describe what they see in their own way.

4.0 Summary

This unit has addressed the concept of philosophy of science and scientific explanations adopting some models such as Deductive-Nomological (D-N), Inductive Statistical (IS) and Statistical Relevance (SR) with some specific examples. The basis for the validity of scientific explanations and objectivity of observation in science were also addressed.

5.0 Self-Assessment Questions

i. List the three (3) cardinal aims of science
ii. List three (3) models used for scientific explanations with an example each.
iii. Explain the basis for the Validity of Scientific Explanations
iv. Enumerate the importance of Objectivity of Observations in Science

6.0 Tutor Marked Assessment

i. State Newton's Third Law of Motion
ii. Use law in i as an example for the basis for the Validity of Scientific Explanations
iii. Enumerate the Shortcomings of the Deductive-Nomological Model
iv. Enumerate the Shortcomings of the Inductive-Statistical Model

7.0 Further Reading

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Module Three

CONCEPT OF MATTER

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INTRODUCTION

This chapter discusses the concept of matter. Often one keeps in the mind what he thinks matter is. It does not imply universal definition. Concept is like an accepted norm or definition. So, while trying to understand matter, the adopted concept is what is perceived and accepted as matter. Interestingly, only two kinds of matter exist in the world.

Learning Outcomes

At the end of this module, you should be able to:

(i) define matter
(ii) describe the scientific methods of studying matter.
(iii) classify matter based on its composition and physical states
(iv) explain the kinetic theory of matter
(v) define what an atom is and explain properties of the 3 sub atomic particles
(vi) explain the significance of Nuclear change

Main Body

Introduction

The module introduces you into the concept of matter vis-a-vis the Kinetic Theory, States of Matter and Nuclear Threats. This module is divided into three units as follows:
Unit 1: Definition of Matter
Unit 2: Change of State of Matter
Unit 3: Nuclear Change

UNIT 1: DEFINITION OF MATTER

Contents

1.0 Introduction

Often one keeps in the mind what he thinks matter is. It does not imply universal definition. Concept is like an accepted norm or definition. So, while trying to understand matter, the adopted concept is what is perceived and accepted as matter. Interestingly, only two kinds of matter exist in the world.

2.0 Learning Outcomes

At the end of this unit, you should be able to:

(i) define matter
(ii) describe the scientific methods of studying matter.
(iii) classify matter based on its composition and physical states
(iv) explain the kinetic theory of matter

3.0 Main Contents

3.1 What is Matter?

The simplified definition of matter is anything that occupies space, possesses mass of its own, offers resistance to change of inertia and may be felt by any of our sensory organs.

Matter exists as a living and non-living entity. Living matter has the properties of respiration, growth, movement, metabolism (eating and excretion) and reproduction. Non-living matter does not exhibit the above properties. Growth in non-living matter only comes if there is an addition of the same or different matter by some processes to the matter.

Matter is constituted. This means that matter is also made up of something else. Matter by its composition can be divided into: Pure substances and Mixtures. Matter can also exist in any

of the three physical states which are solid, liquid, gas or plasma.

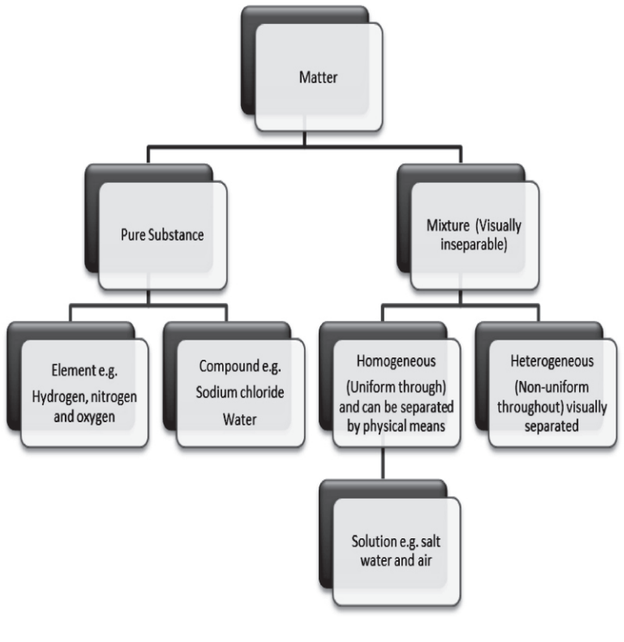

Fig. 1: Classification of Matter

Matter can be represented pictorially while a theory is a statement of facts for understanding, explaining and making predictions about an observable phenomenon. It is used as a plausible general principle to explain a phenomenon. A scientific law is a statement of fact that has been subjected to critical analysis, experimentation and found to correctly explain an observable phenomenon under condition(s) stated.

An element has only one type of atom e.g. hydrogen. About 118 elements exist in nature and are arranged into eight (8) periods of the periodic table. These elements are found naturally in one of the three physical states of matter for example (mercury, bromine as liquid; sodium, copper as solid and hydrogen, oxygen as gas.

A compound has more than one type of atom bonded together chemically which can only be separated by a chemical process e.g. H_2O is made up of hydrogen and oxygen.

A mixture however is made up of more than one element or compound in a weak bond that requires no chemical process to separate, but requires only a simple physical procedure. For example a class of boys and girls is a mixture that can be separated by simple instruction of

"boys, sit down" and "girls, stand up". When matter exists as a mixture, it could be homogeneous such as a solution (e.g. salt in water) or air mixture (e.g. mixture of N_2, O_2, CO_2, H_2O) or heterogeneous mixture such as chocolate or soil.

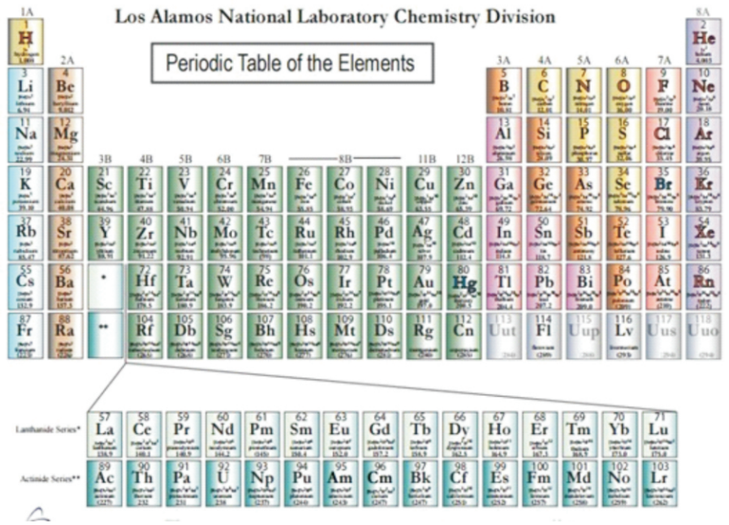

Fig. 2: The Periodic table of elements

Attempt to develop the concept of matter involves many propositions and developing hypothesis. From such hypothesis, theory of matter emerges. The first step is to know the properties of matter.

3.2 The Kinetic theory of Matter

The word kinetic stands for motion while a theory is a statement of facts for understanding, explaining and making predictions about an observable phenomenon. It is used as a plausible general principle to explain a phenomenon.

The Greeks in the early stages of formulation of the kinetic theory conceptualized that if attempt is made to continually subdivide matter, a smallest one will be attained that can exist on its own. This is discrete, that is, it is a repeatable entity, cannot be continuously fractionalized at will. This entity is called molecule and it is made up of one or more atoms.
This means we can explain the behaviour of matter by understanding its state or motional behaviour (kinetics)

The ***particles of solids*** only vibrate and rotate about ***a mean*** position.
Particles of liquids vibrate and rotate about a mean position but can also easily slide over each other.
Particles of gas move randomly and are translated from one place to another.

In building up the kinetic theory, some fundamental assumptions are made and employed. They are:

(1). Particle dimension is much less than the distance between collisions.
(2). Particle velocity is large such that there are many collisions occurring in a short time interval.
(3). Separation between particles is large such that mutual columbic (charged particle) forces of attraction or repulsion are negligible.
(4). Collisions between particles are perfectly elastic.
(5). Particles have no sense of history between collision.
(6). Motion is random.

4.0 Summary

Matter is anything that occupies space and possesses mass of its own. Matter can also exist in any of the three physical states which are solid, liquid, gas or plasma. The behaviour of matter can be explained by understanding its state or motional behaviour (Kinetic Theory).

5.0 Self-Assessment Questions (SAQs)

i. Define matter.
ii. Describe the scientific methods of studying matter.
iii. Classify matter based on its composition and physical states
iv. List the assumptions of the Kinetic theory of matter.

6.0 Tutor Marked Assignments (TMAs)

. Use an appropriate chart to classify matter based on composition.
. Differentiate between the kinetics of the three states of matter
. Define the following terms:
  i. Elements
  ii. Compounds
  iii. Mixtures

7.0 Further Reading

Cutnell, J.D. and Johnson, K.W. (1989) Physics, John Wiley and Sons, NY

UNIT 2: CHANGE OF STATE OF MATTER

Contents

1.0 Introduction

Matter is able to transform from one physical state to another. The state in which matter exists at a given time depends on how closely held its particles are. There are three state of matter which are solid, liquid and gas or plasma. The subatomic particles of atoms are also explained.

2.0 Learning Outcomes

At the end of this unit, you should be able to:

(i) describe the three states of matter
(ii) explain the temperature dependence on state
(iii) list the subatomic particles of an atom

3.0 Main Contents

3.1 States of Matter

Matter can exist in any of the three physical states which are solid, liquid, gas or plasma. Matter takes its own shape when in solid form. It takes the shape of the container when in liquid (and flows when poured) and occupies all available spaces as gas or plasma. The state of matter is distinguishable by the temperature and appearance of the matter.

3.2 Changes in State of Matter

Matter is capable of change from one physical state to another due to temperature change experienced by the matter. The change may involve transformation of form when a chemical reaction is involved. The former is referred to as physical change and the latter as chemical change.

The nature of matter obtained when a chemical change occurs is fundamentally different from the starting matter. For example, when an iron bar is exposed to the right humidity, temperature and air, it rusts. The product of rust is different from the pure iron bar.

All physical change involves change of state. Many a time, matter changes from solid to liquid and to gas but in few others, it changes from solid to gas without passing through liquid state. Such substances are said to sublime and the process of change is sublimation. Examples include iodine and ammonium chloride.

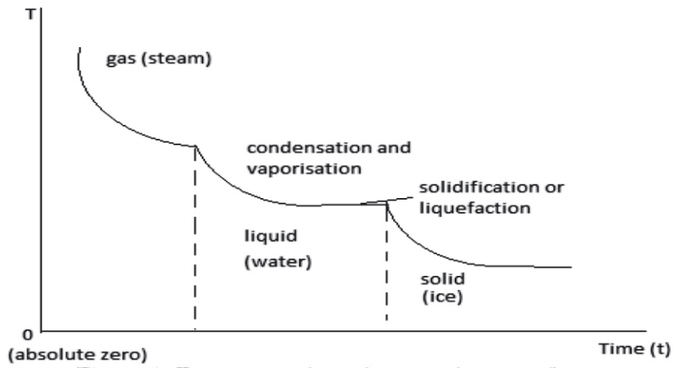

Figure 1: Temperature dependence on the state of matter

3.3 Subatomic Particles

Beyond the atomic study are the subatomic particles revealed by probes made using x-rays. Atomic models were constructed by Rutherford and Bohr. The model showed that the atom had a small positively charged nucleus surrounded by electrons. Hydrogen is the smallest atom having nuclear particle of one proton and an electron moving round it in spherical orbit as shown fig.2

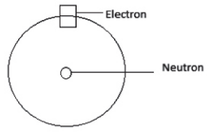

Figure 2: The planetary model of atom

More complicated nucleons have electrons moving in elliptical orbits. The nucleus contains protons and neutrons with the following properties,

Particle	Symbol	Charge	Mass
Proton	p	positive (+1)	1.673×10^{-27}kg
Neutron	n	neutral (0)	1.675×10^{-27}kg
Electron	e	negative (-1)	9.1×10^{-31}kg

where charge of 1e = 1.602×10^{-19} Coulombs

A neutral atom always has equal number of protons and electrons since the neutron has no charge.
Positive and negative charges (positive-negative or negative-positive) attract each other while two similar charges (positive-positive or negative-negative) repel each other.

1.0 Summary

Matter can exist in any of the three physical states which are solid, liquid, gas or plasma. Matter is capable of change from one physical state to another due to temperature change experienced by the matter. The subatomic particles are protons, electrons and neutrons.

2.0 Self-Assessment Questions (SAQs)

i. State the three states of matter.
ii. What are the transformation processes between the states of matter.
iii. List the 3 subatomic particles with their symbols and charges.

3.0 Tutor Marked Assignments (TMAs)

1. What is sublimation? Give two types of substances that sublime.
2. Define condensation.
3. Differentiate between a physical and chemical change in state.

4.0 Further Reading

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UNIT 3: NUCLEAR CHANGE

Contents

1.0 Introduction

The nucleus of the atom is very vital to the composition and properties of an atom and a lot of processes and application arises from this particle.

2.0 Learning Outcomes

At the end of this unit, you should be able to:

(i) describe the changes that occur in the nucleus
(ii) explain a mass defect
(iii) understand the threats and implications of nuclear war

3.0 Main Contents

3.1 Nuclear Change

A nuclear change is one involving either fission (splitting) of the nucleus of an atom, or fusion (combining) of neutrons and protons to form heavier atoms. It involves about 1,000,000 times as much energy as a chemical change.

Some elements are observed to undergo nuclear change. These elements are said to be radioactive e.g. uranium. They emit radiation which can be split using magnetic or electric field as shown in Figure 1.

An example of this reaction that leads to the emission of alpha particle is:

$$^{226}_{88}\text{Ra} \longrightarrow {}^{222}_{86}\text{Rn} + {}^{4}_{2}\text{He} + \text{radiation}$$

Other types of radiations are X-rays.
Both alpha and beta particles are deflected by magnetic and electric plates (field) where alpha particle is Helium nucleus and beta particles are electrons.
Examples of other nuclear reactions are:

$$^{1}_{1}\text{H} + {}^{1}_{1}\text{H} \longrightarrow {}^{2}_{1}\text{D} + {}^{0}_{1}\text{e}\,(+\beta^{+}) + v$$

hydrogen hydrogen duetrium positrion nuetrir

$$^{3}_{1}\text{H} \longrightarrow {}^{3}_{2}\text{He} + {}^{0}_{-1}\text{e}\,(+\beta^{-}) + \dot{v}$$

tritium helium beta-particle anti-nuetrino

The above are called nuclear reactions.
A nuclear particle is represented as: $^{A}_{Z}X$ where A is the mass number, Z is the proton number, and N is the neutron number.

Nuclear reactions are divided into two types:

Nuclear Fusion which is bonding together of two or more nuclei

Nuclear fission is division of a nucleus into two or more smaller nuclei

3.2 Mass defect during nuclear change

During nuclear reaction, mass defect Δm is observed. Δm is the difference in mass between the mass of the product and the reactants. This seems to imply violation of the law of conservation of mass. This law has been restated as the law of conservation of energy when Albert Einstein showed that the change in mass turned into energy, obeying the Einstein law:
$E = \Delta mc^2$
Mass defect Δm is calculated from the knowledge of values of the mass of protons, neutrons, electrons, etc.
A nucleus $^{A}_{Z}X_{N\,N}$ has mass ZM_H^{+} since it contains Z protons and (A-Z) M_n for (A-Z) neutrons and the addition of these two masses when subtracted from the mass of is found not to be equal to zero. It gives mass defect Δm i.e. in its formation from constituent particles; the product has mass defect Δm.

$$\Delta m = ZM_H + (A\text{-}Z)\,M_n - M_A$$

This change in mass then shows up as energy. So the mass and energy become synonymous.
Mass can change into energy and vice versa. This energy is observed in other nuclear reactions such as fission or fusion and is about 200 Mega - electron volts (200 MeV)

3.3 Threats and Implications of Nuclear War

The energy released during nuclear reactions is enormous. It is of the order of mega-electron volts or millions of electron volts (MeV). The magnitude of the energy produced in a nuclear reaction by 1g of uranium nuclear fuel is 1/235 **x** 6.02 **x** 10^{23} **x** 133 200MeV = 68100 **x** 10^{9}GJ.
What makes it of special concern is that this enormous amount of energy is released in a short time on a small piece of land - area producing tremor with tremendous impact over long range. When such a war is becoming feasible, it is considered a **threat**. If it eventually happens; it is then a nuclear **war** and the consequence(s) is/are regarded as the implication(s) of such war. It is important therefore to understand the nuclear energy involved.

Chain reaction

Chain reaction occurs when proceed of one reaction leads to another with both source and product initiating the next reaction and resulting in an avalanche. This result in multiples of the energy produced per step and in a very short time large amount of energy is released. This large amount of energy is released in a very short time to a very small volume of space resulting in an **explosion or a bomb.**

In 1944, during World War II, Hiroshima and Nagasaki in Japan were bombed using hydrogen bomb in which 150,000 lives were lost in that test or drop. World War II quickly wound up within a year of its drop. Besides those who died instantly, many who suffered

from the dust, clay or even after- shock either died, became cancerous, disabled or deformed and so on. Its other effects which include psychological disorder linger on for many years. This scenario is well depicted in the film "The Day After".

In 1946, the United States of America Congress passed the Atomic Energy Act. In the same year following agitations to have arms control and disarmament including right to acquire Nuclear Free Zone, the ***"Nuclear Non-Proliferation Treaty"*** was signed in the League of Nations that transformed into the United Nations. The intention was not to ever have to use this weapon of mass destruction. Signing of this treaty was made voluntary. Those who had the capability to develop nuclear warheads first constituted themselves into superpowers with veto power in the Security Council of the United Nations

4.0 Summary

The magnitude of the energy produced in a nuclear reaction has been shown to be very large. This large amount of energy is released in a very short time to a very small volume of space resulting in an explosion or a bomb. The fission reaction energy can be trapped as heat energy and the heat energy can then be converted to electrical energy which is a positive use. But its use in warfare can be very catastrophic. Treaties are also being formulated to keep space free and to free other planets from nuclear pollution.

5.0 Self-Assessment Questions (SAQs)

i. What is a nuclear change?
ii. Define chain reaction.
iii. Describe a mass defect.
iv. List 3 implications of nuclear threats.

6.0 Tutor Marked Assignments (TMAs)

1. Differentiate between Nuclear fission and fusion
2. What do you understand by the Nuclear Non-Proliferation Treaty.
3. List 3 applications of nuclear technology.

7.0 Further Reading

Marion, J.B. And Hornyak, W.F.,(1982) Physics for Science and Engineering. Part 1, CBS College Publishing, NY, USA.

Tyder, F (1974) A Laboratory Manual of Physics, Fourth Edition, Edward Arnold (publishers) Lid, London.

Module Four

CONSERVATION OF CONVENTIONAL AND RENEWABLE ENERGY SOURCES AND THEIR CONVERSION TECHNIQUES

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INTRODUCTION

Energy is one of the most fundamental parts of our universe. Everything we do is connected to energy in one form or another. We use energy to do work. Therefore, energy drives our day to day activities, at home, schools, businesses or offices. Concern for generation and access to available energy remain issues of national interest while energy trapped in diverse and abundant natural resources within our immediate environment remains unharnessed for human utilization.

Therefore, in this module, efforts are made to discuss about energy and its conversion from one form to another. Types, workability, advantages and disadvantages are discussed. Conversion of potential energy to kinetic energy, chemical to electrical to light energy, electric to heat energy, heat energy to electrical energy and heat energy to light energy are discussed. Also, conversion of mechanical energy to electrical to heat energy; and conversion of electrical energy to mechanical and to sound energy are discussed.

Learning Outcomes

i. sources and types of natural and conventional energy;
ii. differentiate between natural and conventional, and renewable and non renewable sources of energy;
iii. concept of energy sources and conservation methods;
iv. sources and types of biomass resources;
v. diverse methods of application of biomass and conversion techniques to renewable energy;
vi. advantages of biomass as energy source; and method of production of biofuel / bio diesel and food security

MAIN BODY

Introduction

The module discussed extensively on conservation of conventional and renewable energy sources and their conversion techniques. The module is discussed under 2 units.

Unit 1: Conservation of Natural and Artificial Energy Resources
Unit 2: Biomass as Sustainable Sources of Renewable Energy

UNIT 1: CONSERVATION OF NATURAL AND ARTIFICIAL ENERGY RESOURCES

Contents

1.0 Introduction

In this unit, efforts are made to discuss about natural and artificial energy resources and its conversion from one form to another.

2.0 Learning Outcomes

At the end of this unit, you are should be able to:

i. Identify the difference between renewable and non-renewable sources of energy;
ii. Describe at least 5 types of energy

iii. Describe the methods for converting energy from one form to another;
iv. State at least five advantages and disadvantages of solar, fossil fuel, wind, tidal, hydroelectricity, geothermal and nuclear energy.

3.0 Main Content

3.1 Review of Energy and its Conversion

Animals convert food to energy in order to run. Plants grow through the grace of solar energy. Arrows fly by converting the potential energy of a stretched bow to the kinetic energy of the moving arrow. Water flowing downward from the top of a dam converts gravitational potential energy into energy of motion. Combustion engines in motor vehicles convert chemical energy in gasoline and oxygen into energy of motion. Solar energy is radiated to us continually and without it, and the food-producing plants it supports, we could not survive. For sundry other functions, we rely on the fossil fuels (coal, petroleum and natural gas) and uranium. They are burned in the earth's crust and whatever their abundance they are limited and will eventually be depleted hence we think of alternatives.

Energy is needed for a person to work, to jump, to run, to eat and for plants and animals to grow. It is present in various forms such as in the electricity, which lights lamps and makes television sets produce pictures. Energy is also present in the coal and oil, which is use as fuel in furnaces, engines of cars and airplanes. The chief forms of energy are: mechanical, chemical, heat, nuclear and energy of electromagnetic radiation. These constitute conventional energy. The non-conventional energy includes fossil fuel, biomass, hydroelectric power, nuclear, geothermal, wind, tidal and solar. Energy are classified into renewable and nonrenewable, because their supplies are limited, conventional and non-conventional, deepening on regular use and the green and non green forms of energy, which depend on their effect on the environment. **Renewable energy sources** include biomass, geothermal energy, hydropower, solar energy, and wind energy. They are called renewable because they are replenished in a short time. Effort is made here to discuss some of these energies.

3.1.1 Mechanical Energy

Kinetic Energy: This is the energy associated with masses in motion. An example of this type of energy is when a boy runs or when water is pouring down a waterfall. It is half the product of mass and its velocity square.

Potential Energy: This is the energy possessed by a system or an object due to its position. There are varieties of potential energies; as examples: there is mechanical potential energy in the wound spring of a clock or a stretched bowstring. There is gravitational potential energy in anything lifted against the pull of gravity, such as a stone lifted by a person. There is chemical potential energy in almost every known substance, since there is hardly anything

known which will not react with some chemical agent and release its energy. There is electrical potential energy stored in an electrical field. The water at the top of a dam has potential energy and the potential energy depends on the mass, height, gravity and density.

***Electrical Energy*:** Electricity is different from the other energy sources because it is a secondary source of energy. We must use another energy source to produce electricity.

Electricity is sometimes called an **energy carrier** because it is an efficient and safe way to move energy from one place to another, and it can be used for so many tasks. As we use more technology, the demand for electricity grows.

The rate of charge flows of electricity with time is called electrical current, it is measured in ampere. The current that flows through a metallic conductor is proportional to the potential difference across its ends, provided temperature and all other physical quantities are constant. The constant of proportionality is Resistance, measured in Ohms.

Power is the rate of using or producing energy, it is measured in watt.

3.2 Natural Sources of Energy

3.2.1 Solar Energy

We have used the sun for drying clothes and food for thousands of years, but only recently have we been able to use it for generating power. The sun is 150 million kilometers away, and amazingly powerful. Just the tiny fraction of the sun's energy that hits the earth (around a hundredth of a millionth of a percent) is enough to meet all our power needs many times over. Infact, every minute, enough energy arrives at the earth to meet our demands for a whole year, if only we could harness it properly.

How it works

There are three main ways in which the energy from the sun can be utilized:

(a) Solar cells (really called "photovoltaic" or "photoelectric "cells) convert light directly into electricity. In a sunny climate, you can get enough power to run a 100w light bulb from just one square metre of solar panel. (Fig. 3.1).

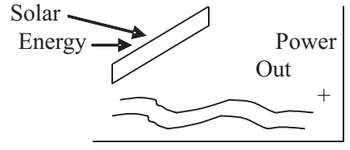

Fig. 1.1 Solar Cells Convert Light Directly to Electricity

Solar cells are used for mini electrical appliances such as calculators, cell phones etc. Solar cells provide energy to run satellites that orbit the earth, used for satellite TV, telephones, navigation whether forecasting, internet etc.

(b) Solar Water Heating

(i) Heat from the sun is used to heat water in glass panels on the roof. This means too much gas, or electricity, or kerosene or firewood is not used to heat the water used in the home. Fig. 1.2 presents the arrangement of solar water heating.

(ii) Water can be pumped through pipes in the panel. The pipes are painted black, so they get hot when the sun shines on them.\

This helps out your central heating system and cuts your fuel bill. However, in the U.K or U.S.A, you must remember to drain the water out to stop the panels freezing in the winter.

Solar heating is worthwhile in places like California, USA and Australia, where lots of sunshine is obtained. As technology improves, it becomes worthwhile in the U.K. However, during summer in the U.K, a lot of domestic water can be heated.

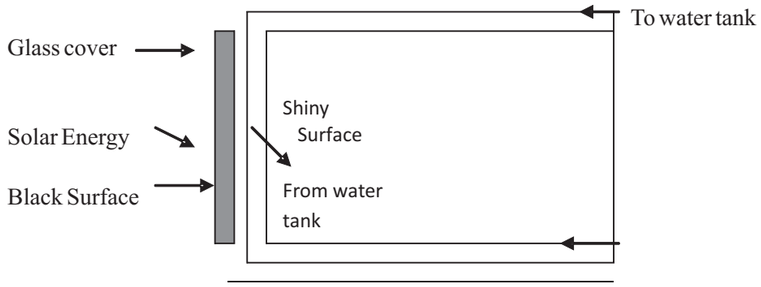

Fig. 1.2: Solar Water Heating

c) **Solar Furnaces**

Solar furnaces use a huge array of mirrors to concentrate the sun's energy into small

space and produce very high temperatures. There is one at Odellio, France, used for scientific experiments up to 33,000 degrees Celsius.

Advantages of Solar Energy

i. Solar energy is free. It needs no fuel and produces no waste or pollution.
ii. In sunny countries, solar power can be used where there is no easy way to get electricity to a remote place
iii. Handy for low-power uses such as solar powered garden lights and battery chargers.

Disadvantages of Solar Energy

i. The does not shine at night
ii. Very expensive to build solar power stations because of the cost of solar cells.
iii. Can be unpredictable except you are in a very sunny climate.

3.2.2 Wind Energy

The sun heats the atmosphere unevenly, so some patches become warmer than others. Fig. 1.3 shows arrangement of wind energy assembly. The warm patches of air rise, other air blows in to replace them, hence wind blows. A wind turbine converts the Kinetic energy of the wind into rotational mechanic energy. The energy imparted to the rotating turbine increases as the wind speed increases. Also, the larger the diameter of the rotating blades, the more the energy that is obtained from the turbine power that can be extracted from the air stream is given by $P = 0.5d^2v^3$ watts. d = diameter of the propeller in metres, v = speed of the wind in m/s

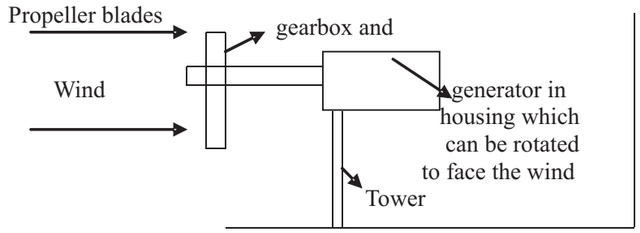

Fig. 1.3: Arrangement of Wing Energy Assembly

Advantages of Wind Energy

i. Wind is free, wind farms need no fuel.
ii. Produces no waste or greenhouse gases
iii. The land beneath can be used for farming.

iv. Wind farms can be tourist attractions
v. A good method of supplying energy to remote areas especially in desert land

Disadvantages of Wind Energy

i. The wind is not always predictable.
ii. Suitable areas for wind farms are often near the coast, where land is expensive.
iii. Some people feel that covering the landscape with these towers is unsightly.
iv. Can kill birds when wind farms are built on migratory rootes, since migrating flocks tend to like strong winds which blow birds to them.
v. Can affect television reception of anybody that lives nearby.
vi. Can be noisy. Wind turbines have a reputation for making a constant, low, 'swooshing' noise day and night.

3.2.3 Hydroelectricity

Gravitational potential is stored in the water above the dam. Because of the great height of the water, it will arrive at the turbines at high pressure, which means that a great deal of energy can be extracted from it. The water then flows away down the river normally.

In mountainous countries such as Switzerland and New Zealand, hydro – electric power provides more than half of the country's energy needs.

Advantages of Hydroelectricity

i. Once the dam is built, the energy is virtually free.
ii. No waste or pollution is produced.
iii. Much more reliable than wind, solar or wave power.
iv. Water can be stored above the dam ready to cope with peaks in demand.
v. Hydro-electric power stations can increase to full power very quickly, unlike other power stations.
vi. Electricity can be generated constantly.

Disadvantages of Hydroelectricity

i. Dams are very expensive to build.
ii. Building a large dam will flood a very large area upstream, causing problems for animals that live there.
iii. Finding a suitable site can be difficult – the impact on residents and the environment may be unacceptable.
iv. Water quality and quantity downstream can be affected, which can have an impact on plant life.

3.2.4 Tidal Energy

The oceans contain an enormous amount of thermal energy but it cannot be extracted by a heat engine whose operating temperature matches the surface temperature of the ocean. However, a condition exists for extracting heat from the upper part of the ocean, converting some of the energy to useful work, and rejecting the remainder to the cooler deep region. This is by the use of the Ocean Thermal Energy Converter.

The features of ocean thermal Energy Converters (OTEC) are that they:

1. are essentially pollution free and
2. make use of the sun, which replenishes the internal energy of the ocean surface with its radiation.

Constructing such a system in the ocean presents some engineering problems. At present, there are about two tidal power schemes operating in the world, one in France and the other one in Russia.

Advantages of Tidal Energy

i. The energy is free – no fuel needed, no waste produced
ii. Not expensive to operate and maintain.
iii. Can produce a great deal of energy.
iv. It produces no greenhouse gases or other wastes.

Disadvantages of Tidal Energy

i. Depends on the waves-sometimes loads of energy are obtained, sometimes nothing.
ii. Needs a suitable site, where waves are consistently strong.
iii. Some designs are noisy.
iv. Must be able to withstand very rough weather.
v. Only provides power for around ten hours each day, when the tide is actually moving in or out.

3.3 Conventional and Non Renewable Energy Sources

3.3.1 Fossil Fuels

Coal, oil and gas are called 'fossil fuels' which provide about 66% of the world's electrical power and 95% of the world's total energy demands (including heating, transport, electricity generation and other uses). They are the end product of a natural process of decomposition of vegetable matter buried in swamps and out of contact with oxygen for thousands of years.

How it works

The word 'coal' denotes a wide variety of solid fuels. The varieties in approximate order of their formation are peat, lignite, bituminous coal and anthracite.

Coal is crushed to a fine dust and burnt. Oil and gas can be burnt direct.

Burn Fuel → Heat water to make steam → Steam turn turbines → Turbines turn generators → electrical power sent around country

Coal provides around 28% of our energy, and oil provides 40 %. Burning coal produces sulphur dioxide, an acidic gas that contributes to the formation of acid rain.

Natural gas is a mixture of various compounds of carbon and hydrogen and small quantities of non-hydrocarbons existing in the gaseous phase, or in solution with oil, in natural underground reservoirs. It is classified into two categories;

Associated gas and Non-associated gas.

Associated gas is natural gas originating from fields producing both liquid and gaseous hydrocarbons simultaneously. On the other hand, non-associated gas is natural gas which is obtained independently. It is generally found in the space above an oil reservoir or an aquifer. Typically the major constituents of associated natural gas are methane (about 50 per cent by volume), ethane (about 20 per cent) and propane (about 10 per cent). The major constituent of non-associated natural gas is methane (more than 90 per cent by volume).

Natural gas provides around 20% of the world's consumption of energy, and as well as being burnt in power stations, is used by many to heat their homes.

Advantages of Fossil Fuels

i. Very large amounts of electricity can be generated in one place using coal, fairly cheaply.
ii. Transporting oil and gas to power station is easy.
iii. Gas-fired power stations are very efficient
iv. A fossil fuelled power station can be built anywhere, so long as you can get large quantities of fuel to it. Didcot power station in Oxfordshire has a dedicated rail link to supply the coal

Disadvantages of fossil fuels

i. Basically, the main drawback of fossil fuels is pollution. Burning any fossil fuel

produces carbon dioxide, which contributes to the 'greenhouse effect' warming the earth.

ii. Mining coal can be difficult and dangerous. Strip mining destroys large areas of the landscape

iii. Burning coal produces more carbon dioxide than burning oil or gas. It also produces sulphur dioxide, a gas that contributes to acid rain. We can reduce this before releasing the waste gases into the atmosphere.

iv. Coal-fired power stations need huge amounts of fuel which means train-loads of coal almost constantly. In order to cope with changing demands for power, the station needs reserves.

This means covering a large area of country-side next to the power station with piles of coal.

3.3.2 Nuclear Energy

Nuclear power is generated using Radio nuclei, such as uranium, for fission or very light nuclei for fusion.

Fission or Fusion makes sent heat	⟶	heat water to make steam	⟶ steam turns turbines	⟶ turbines turn of generators	⟶ electrical p o w e r

Nuclear reactors must have strategic arrangement for

1. removing thermal energy from the reactor and
2. a scheme for controlling the energy output.

Russia, France and England have successfully operated nuclear breeder reactor electric power plants.

Special Problem with handling Plutonium

Extracting plutonium is not simple because the element is extremely dangerous. It has chemical effects on the body. Also, it is radioactive and it decays by emitting alpha particles, which are among the most damaging nuclear particles to the internal organs of the human body. If plutonium is taken into the body in soluble form, it concentrates in the bones and the liver and tends to remain there. If taken into the lungs as small particles, it can produce intense local damage and possibly induce cancer. For these reasons, plutonium processing is done by remote control method. Another problem is that plutonium can be stolen to produce atomic bomb such as the one used in World War II.

Nuclear fusion Reactors

Fusion occurs when two light nuclei are fused together to form a heavier nucleus and energy is released.

Problem of Fusion

Very high temperature of the order of 10^8 K is required to overcome the coulomb repulsive forces between two light nuclei. This poses severe technological problem due to the fact that materials that withstand such a high temperature are difficult to come by.

Advantages of Fusion over Fission

1. Easily achieved with highest elements.
2. Raw materials are cheaply available. Hydrogen can be obtained by electrolysis of seawater which is cheap and plentiful for use.
3. Produces less dangerous by-products.
4. By-products are non-radioactive

In Britain, nuclear power stations are built on the coast and sea water is used for cooling the steam which is ready to be pumped. Also, carbon dioxide gas is blown through the reactor to carry the heat away. Carbon dioxide is chosen because it is very good coolant, able to carry a great deal of heat energy. It also helps to reduce any fire risk in the reactor (it is around 600°C). Any country that produces energy through nuclear reactor should have computers that will shut the reactor down automatically if things get out of hand. At Chernobyl, in Ukraine, they did not have such a sophisticated system. The reactor overheated, melted and excessive pressure blew out the containment system before they could stop it. Then, with the coolant gone, there was a serious fire. Many people lost their lives.

Advantages of Nuclear Power

1. Nuclear power costs about the same as coal. So it is not expensive to make.
2. Does not produce smoke or carbon dioxide, so, it does not contribute to the greenhouse effect.
3. Produces huge amounts of energy from small amounts of fuel.
4. Produces small amounts of waste
5. Nuclear power is reliable.

Disadvantages of Nuclear Power

1. Although not much waste is produced, it is very, very dangerous. It must be sealed up and buried for many years to allow the radioactivity to die away.
2. Nuclear power is reliable, but a lot of money has to be spent on safety. If it goes wrong a nuclear accident can be a major disaster.

3.3.3 Geothermal Energy

Geothermal energy is energy from heat inside the earth Thermal energy within the earth is termed geothermal energy. Human beings live on a crust of earth with varying thickness. Beneath the crust is a semi-molten rock layer called the mantle. Beneath the mantle is a molten core of iron and nickel. The earth's crust is warmed from within by the hot interior and by radioactive decay products, in particular, emissions from uranium – 238, thorium – 232 and potassium – 40. The temperature of the crust increase about 2^{o}C for each 100-m penetration. Geothermal energy is difficult to exploit. However, there are areas in which hot molten rock (magma) is forced up through structural defects and these sometimes produce concentrated sources of hot water or steam that can be tapped for a variety of energy uses. Thermal energy can be extracted by drilling to the rock. Injecting water into the entrance and recovering the steam formed when the water contacts the hot dry rock.

Although present in many parts of the world, these systems are probably incapable of making a substantial contribution to the energy demand of the industrialized nations, but could, on the other hand, constitute the decisive factor for the industrial take-off of many developing countries. New technologies are being studied or experimenting for creating artificial hydrothermal systems so that geothermal energy could make a significant contribution to the world's energy demand.

Types of Geothermal Fields

1. **Hot water fields**: These contain water in the 50^{0} – 100^{0}C temperature rage, which can be utilized for domestic heating, agricultural heating (that green house) or in industrial processes requiring heat.
2. **Wet Steam fields**: These contain pressurized water at temperatures that are usually well above 100^{0}C, and small quantities of steam in the shallower, lower pressure parts of the reservoir. An impermeable cap rock prevents the fluid from escaping to the surface, thus, keeping it under pressure.
3. **Superheated Steam fields**: These are similar geologically to the wet steam fields. The water and steam coexist, with steam as the continuous predominant phase. This type of field produces dry steam (with no water in the liquid phase) generally superheated, with small quantities of other gases, particularly CO^{2} and S^{2}. The superheated steam is used in generating electricity.

N.B: The electric energy produced by geothermal means is nowadays competitive with all other renewable and conventional energy sources and can draw on a technology based on some tens of years of work experience.

Advantages of geothermal Energy

1. Geothermal energy does not produce any pollution, and does not contribute to the greenhouse effect.

2. The power stations do not take up much room, so there is not much impact on the environment.
3. No fuel is needed
4. Once the geothermal power station is built, the energy is almost free.

Disadvantages of Geothermal Energy

1. The big problem is that there are not many places where a geothermal power station can be built. This is because hot rocks of suitable type are needed.
2. Sometimes a geothermal site may 'run out of steam' perhaps for decades.
3. Hazardous gases and minerals may come up from underground and can be difficult to safely dispose of.

3.4 Conservation of Energy

One kind of energy may be converted easily into another such as potential to Kinetic type or chemical to electrical form, while the total energy always remains the same. That is, energy is neither created nor destroyed in any given physical system. This idea is called the law of conservation of energy.

Examples of the law of conservation of energy are: when a bullet leaves a gun with a certain kinetic energy. As it flies through the air, some of its energy is lost, some of its energy is energy due to its friction with the air. As the bullet strikes its target, more energy is converted to sound and light. Heat will also be developed in the target. Another example is the kinetic energy of wheel as it spins can lift water and store it in a tank. The work done in lifting the water is stored as potential energy. If the water is allowed to fall back to earth, this potential energy is again converted to kinetic energy.

Further example is when Zinc and copper bars are partially immersed in a sulfuric acid solution, a chemical reaction takes place. If the parts of these bars that are above the surface of the acid solution are connected to each other by a wire, it will be found that an electric current will flow through this wire. This arrangement is called voltaic cell. If a globe is connected to this arrangement, it will glow. Can we add more examples from our day to day experiences?
The following is also an example of transformation of different forms of energy into heat and power.

Oil burns to make heat ⟶ Heat boils water ⟶ Water turns to steam
Steam pressure turns a turbine ⟶ Turbine turns an electric generator ⟶
Generator produces electricity ⟶ Electricity powers light bulbs ⟶ Light bulbs give off light and heat

It is difficult to imagine spending an entire day without using energy. In a home where electricity supplies all of the energy requirements, the average energy consumption is shown below:

Air conditioner and heater		=	50%
Water heater		=	20%
Lighting and small appliances	=	10%	
Refrigerator		=	8%
Other		=	5%
Ovens and stoves		=	4%
Clothes dryer		=	3%

3.5 Importance of Conservation of Energy

Because of the limited amount of nonrenewable energy sources on Earth, it is important to conserve our current supply or to use renewable sources so that our natural resources will be available for future generations.

Energy conservation is also important because consumption of nonrenewable sources impacts the environment. Specially, our use of fossil fuels contributes to air and water pollution. For example, carbon dioxide is produced when oil, coal, and gas combust in power stations, heating systems, and car engines. Carbon dioxide in the atmosphere acts as a transparent blanket that contributes to the global warming of the earth, or "greenhouse effect". It is possible that this warming trend could significantly alter our weather. Possible impacts include a threat to human health, environmental impacts, such as rising sea levels that can damage coastal areas and major changes in vegetation growth patterns that could cause some plant and animal species to become extinct. Furthermore, Sulfur dioxide is also emitted into the air when coal is burned. The sulfur dioxide reacts with water and oxygen in the clouds to form precipitation known as "acid rain". Acid rain can kill fish and trees and damage limestone buildings and statues.

3.6 Conversion Devices for Renewable and Non Renewable Energy

Any known source of renewable energy is not useful in its natural state except it is converted through appropriate conversion devices.

3.6.1 Solar Energy Conversion

The basic components of solar power systems are shown in Fig. 3.4.

Fig. 3.4: Basic components of Solar Power systems
Source: http://www.freesunpower.com/solarpanels.php

Solar Energy is converted into useful form through application of the following conversion devices:

Solar Panels: Solar Panels supply the electricity and charge the batteries.

A Charger Controller: A Charge Controller is needed to prevent overcharging of the batteries. Proper charging will prevent damage and increase the life and performance of the batteries.

The Power Inverter: The Power Inverter is the heart of the system. It makes 120 volts AC from the 12 volts DC stored in the batteries. It can also charge the batteries if connected to a generator or the AC line.

Batteries Storage: Batteries store the electrical power in the form of a chemical reaction. Without storage you would only have power when the sun was shining or the generator was running.

Necessary and proper wires and cables will be needed to connect everything and a meter to keep an eye on things would be nice.

3.6.2 Wind Energy

A typical wind energy conversion system is shown in Fig. 3.5

Fig. 3.5: A typical wind Energy Conversion System
Source: http://www.daviddarling.info/encyclopedia/G/AE_generator.html

The major components of a typical wind energy system include: wind turbine, a generator, interconnection apparatus and control systems. Generators for wind turbines include synchronous generators, permanent magnet synchronous generators, and induction generators which could either be the squirrel-cage type or wound rotor type. For small to medium power wind turbines, permanent magnet generators and squirrel-cage induction generators are often used because of their reliability and cost advantages. Also, induction generators, permanent magnet synchronous generators, and wound field synchronous generators are currently used in various high power wind turbines.

3.6.3 Hydro Power Energy

The major components of a typical hydropower system include:
Penstock: Main pressure building conduit. Must use care if head is large, 130 psi or greater. High head pressure can be dangerous
Hydro Turbine or Wheel: Depending on type of system chosen (Impulse or Reaction)
Gear Box or Belt Drive: Gear belt and belt drive provide most efficient range of Turbine

operation and maintain generator output at correct frequency.
Generator: Most common types used are either synchronous or induction depending on power application.
Power Switch & Breaker: These are safety device to disconnect power
Transformer: AC conversion of generator output voltage to transmission line or use voltage.
AC Output to Load or Grid: Transmission line to point of use, voltage and current define loss based on wire gauge and distance.

1.0 Summary

Energy are classified into renewable and nonrenewable, conventional and non-conventional, and the green and non-green forms of energy, depending on whether their supplies are limited, regular use and their effect on the environment. **Renewable energy sources** include biomass, geothermal energy, hydropower, solar energy, and wind energy. They are called renewable because they are replenished in a short time

2.0 Self-Study Questions

1. Differentiate between renewable and non-renewable sources of energy.
2. List 5 types of energy you know
3. Describe one method for converting one type of energy to another;
4. State five advantages and disadvantages of the following types of energy:
   i. solar
   ii. fossil fuel
   iii. wind
   iv. tidal
   v. hydroelectricity
   vi. geothermal
   vii. nuclear energy.

3.0 Tutor Marked Assignment

1. Describe the energy conversions that take place in the following:
   (a) A boy riding a bicycle
   (b) An electric pressing iron
   (c) Radios and televisions
   (d) The Telephone
   (e) Electric Motor
2. Describe briefly how energy is obtained by
   a) Solar energy
   b) Tidal energy

c) Hydroelectricity
d) Geothermal energy
e) Wind energy
f) Nuclear energy

3. Enumerate distinct features of the following:
a) Conventional Energy Source
b) Non Conventional Energy Source
c) Renewable Energy Source
d) Non Renewable Energy Source

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5.0 Further Reading

UNIT 2: BIOMASS AS SUSTAINABLE SOURCES OF RENEWABLE ENERGY

Contents

1.0 Introduction

This unit introduces various types of biomass as forms of alternative energy. The energy potential of these important commodities are examined. The environmental benefits of biomass are discussed. The processes involved in conversion of biomass to various sustainable energy products are also highlighted with their unique characteristics. The issues related to energy crop and food security were presented and obvious factors that may lead to food shortage and price increase beside production of biofuel from biomass are highlighted.

1.0 Learning Outcomes

At the end of this unit, you are should be able to:

i. Define biomass
ii. List four advantages of biomass as a source of energy
iii. State five methods for transformation of biomass to renewable energy

iv. Identify the challenges of biofuel production in developing countries

1.0 Main Content

3.1 Biomass as Sources of Energy

The term biomass refers to all organic matter generated through photosynthesis and other biological processes. Biomass is considered as the solar energy stored in chemical form in plant and animal materials and it is among the most precious and versatile resources on earth. It provides not only food but also energy, building materials, paper, fabrics, medicines and chemicals. Biomass has been used for energy purposes ever since man discovered fire. Today, biomass fuels can be utilised for tasks ranging from heating the house to fuelling a car and running electrical and electronic appliances.

If we burn biomass efficiently (extract the energy stored in the chemical bonds) oxygen from the atmosphere combines with the carbon in plants to produce carbon dioxide and water. The process is cyclic because the carbon dioxide is then available to produce new biomass. This process leads credence to earnings of Carbon Credit. Hence, use of biomass can help reduce global warming compared to a fossil fuel-powered plant. Plants use and store carbon dioxide (CO_2) when they grow. CO_2 stored in the plant is released when the plant material is burned or decays. By replanting the crops, the new plants can use the CO_2 produced by the burned plants. So using biomass and replanting helps close the carbon dioxide cycle. However, if the crops are not replanted, then biomass can emit carbon dioxide that will contribute toward global warming.
So, the use of biomass can be environmentally friendly because the biomass is reduced, recycled and then reused. Today, new ways of using biomass are still being discovered. One way is to produce ethanol, a liquid alcohol fuel. Ethanol can be used in special types of cars that are made for using alcohol fuel instead of gasoline. The alcohol can also be combined with gasoline. This reduces our dependence on oil or fossil fuel.
Wood may be the best-known example of biomass. But wood is just one example of biomass. Various biomass resources are derived from different sources. Bagasse from sugarcane, corn fiber, rice straw and hulls, and nutshells are examples of agricultural residues. Sawdust, timber slash, and mill scrap are derived from wood waste. Examples of municipal wastes include the paper trash and urban yard clippings. Energy crops are fast growing trees like poplars, willows and jatropha. Grasses like switchgrass or elephant grass are also examples of energy crops. The methane captured from landfills, municipal waste water treatment, and manure from cattle or poultry, are typical examples of biomass. **(Olaoye, 2001; Corcoran et al., 2008).**

3.2 Relationship of Biomass with Renewable and Nonrenewable Energy

Six most utilized renewable energy sources are hydropower, tidal wave, solar, wind, geothermal, and biomass. All energy forms derived from biomass sources are renewable. Renewable energy sources refer to forms of energy sources that can be regenerated in a short period of time after utilization while nonrenewable energy sources cannot be regenerated in a short period of time. Nonrenewable energy are mainly sourced from the ground as

liquids, gases and solids. Examples of these include crude oil, natural gas and coal, respectively. These products are essentially biomass as they formed from the buried remains of plants and animals that lived millions of years ago. Fig. 2.1 shows various forms of renewable and nonrenewable energy.

Fossil fuels contain the same constituents - hydrogen and carbon - as those found in fresh biomass. Environmental impacts pose a significant distinction between biomass and fossil fuels. When a plant decays, it releases most of its energy back into the atmosphere. In contrast, fossil fuels are locked away deep in the ground and do not affect the earth's atmosphere unless they are burned.

Rising world fuel prices, the growing demand for energy, and concerns about global warming are the key factors driving the increasing interest in renewable energy sources and in biomass in particular. Biomass is the best alternative energy source as it is available in large amounts and production of some form of energy from biomass is also less costly. The use of renewable energy is not new. Now biomass that could normally present a disposal problem is converted into electricity and other useful energy alternative.

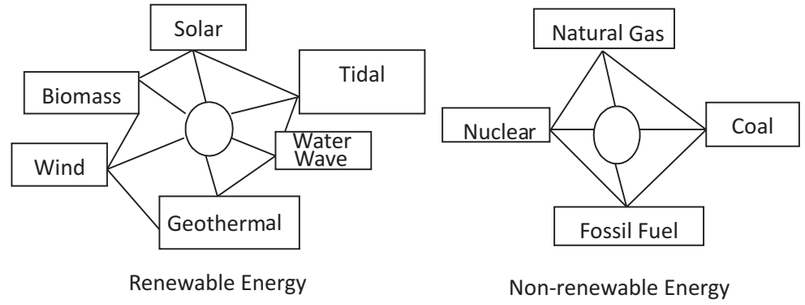

Fig. 3.1: Illustrations of renewable and nonrenewable energy

3.3 Biomass Utilization Now and in the Future

According to *Henniges and Zeddies (2006), b*iomass is considered to be one of the key renewable resources of the future at both small- and large-scale levels. It already supplies 14 per cent of the world's primary energy consumption, and for three quarters of the world's population living in developing countries biomass is the most important source of energy. With increases in population and per capita demand, and depletion of fossil-fuel resources, the demand for biomass is expected to increase rapidly in developing countries. On the average, biomass produces 38 percent of the primary energy in developing countries and about 90 per cent in Brazil. Biomass is likely to remain an important global source in developing countries well into the next century. Even in developed countries, biomass is being increasingly used. A number of developed countries use this source quite substantially, for example in Sweden and Austria, 15 per cent of their primary energy consumption is covered by biomass. Sweden has plans to increase further use of biomass as it phases down nuclear and fossil-fuel plants in the near future. In the USA, which derives 4 per cent of its

total energy from biomass (nearly as much as it derives from nuclear power), now more than 9000 MW electrical power is installed in facilities firing biomass (Keeney and DeLuca, 1992, Rosentrater et al., 2009). In Nigeria, with massive available land and agricultural infrastructure the biomass reserve could, sustainably, revamp the epileptic supply of energy generated through the hydropower plants without any serious threat to food security. Furthermore, biomass can be used to produce ethanol (biofuel) which could reduce also oil imports up to 50 per cent.

Nigeria has abundance of required resources for biomass production. The climatic and ecological ambiences are most suitable conditions for growth of energy crops. All existing opportunities along the production chain from cultivation of energy crop to extraction of ethanol or biodiesel can be exploited as a means of generating employment. The teeming youthful population can provide the desired labour requirements.
Conversion of biomass to energy can become employment generating venture for the nation, leading to strong financial returns. Nigeria has an arable land of 33,000,000 Ha (NBS, 2007). Brazil with similar climatic conditions but smaller arable land area has successfully translated her biomass resources into useful form through production of biofuels from agricultural feedstock. Sambo (2009) estimated the quantities of available biomass resources in million tonnes in Nigeria as follows; fuelwood 39.1, Agro-waste 11.2 and Saw Dust 1.8 while the corresponding heat values in Mega Joules are estimated as 531.0, 147.7, and 31.433, respectively. The resources quantity for Municipal Solid Waste is estimated as 4.075 million tonnes.

Figure 3.2 clearly illustrates various characteristics of biomass and diverse forms of energy that can be produced. Table 2.1 presents different sources of biomass, their forms, and their conversion process to respective forms of energy.

3.4 Transformation of Biomass to Renewable Energy

The processes of conversion of biomass into a useful source of energy include combustion, pyrolysis, **destructive distillation, gasification, anaerobic bio-gasification, fermentation and distillation of alcohol and transesterification of vegetable oil. (**http://www.world-agriculture.com/, http://www.world-agriculture.com/agricultural-bioenergy/ alcoholic-fermentation-process.php, Nan et al., 1994, FOE, 2009).

3.4.1 Combustion

Combustion involves burning of biomass fuels in the presence of air to generate heat energy. Main products of combustion are ash and fuel gases. Usually fuels are burnt on hot furnace. The heat generated is used to drive steam engines and also for irrigation and threshing purposes.

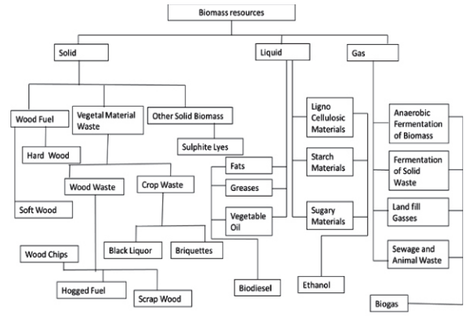

Fig. 3.2: Characteristics of biomass and diverse forms of energy that could be produced

Table 3.1: Biomass Resources, Conversion Process and Energy Derivatives

S/No	Sources of biomass	Forms of biomass	Conversion process	Forms of energy
A	**Plantations**			
1	Siviculture	Fire wood	Combustion	Heat
2	Energy plantation	-do-	Destructive distillation	Charcoal
3	Agriculture	Carbohydrates		Ethanol
4	Energy crops	Hydrocarbons	Fermentation	Fuel oil
5	Aquatic biomass	Aquaculture		Methanol
6	Weeds	Whole plant body		Methane
B	**Residues/wastes/weeds**			
1	Rural/urban wastes/ industrial wastes		Combustion Pyrolysis Fermentation	Fire/fuel Fuel oil Ethanol
2	Forestry wastes	-do-	Combustion Pyrolysis Gasification Fermentation	Fuel Oil gas Gas Ethanol
3	Agricultural wastes	Wastes	Fermentation	Methane
4	Weeds & aquatic biomass	Wastes	Fermentation	Methane
5	Cattle dung	Wastes	Fermentation (biomass)	Methane

Source: http://www.world-agriculture.com, Heiermann, *et al*., 2009

3.4.2 Pyrolysis

Pyrolysis is the process of heating wood and agricultural residues at temperature varying between 540 - 1100 ^{o}C in the absence of air near several hours to breakdown plant materials

into a complex mixture of liquids. Earthen kilns, pit kilns, brick kilns or portable steel kilns are used for this process. The resulting product has a high calorific value, easy to transport, store and distribute and more efficient in burning and has a characteristic feature of creating less pollution. A good example of pyrolysed product is charcoal. From eight tonnes of wood, around one tonne of charcoal can be made. The gases that are produced during the process of pyrolysis can be converted or synthesized into methanol and liquids which are used as fuels. (Shah *et al.*, 1989). Depending on the temperature, the degradation stages of pyrolysis revealed different products. The stages of pyrolysis by breaking down wood and agricultural residues into mixture of liquid in the absence of air are identified by four distinct temperature zones 0 – 170 °C yielding evaporation of moisture, 170 – 270 °C resulting into evolution of carbon monoxide and carbon dioxide, 270 – 400 °C yielding evolution of methanol and at 400 – 500 °C to produce charcoal with optimum carbon content. (http://www.world-agriculture.com).

3.4.3 Destructive distillation

The destructive distillation is carried out in long steel retorts or earthen kilns. Only the wood wastes such as branches, trunks of trees are used as raw materials. The process involves decomposition of wood at high temperatures in the absence of air. At an initial temperature of 230 °C, the moisture is evaporated and then the temperature is raised to 370 °C and maintained for 6 hours. At the end of this period, wood is converted to charcoal which is cooled in the absence of air for 48 hours. After cooling, they are spread in open sheds, two days for drying and thereafter ready for supply to consumers. Figure 3.3 displays a typical setup during the process of destructive distillation of wood in Nigeria to produce charcoal.

Figure 3.3: The process of destructive distillation wood to produce charcoal.

3.4.4 Gasification

Gasification is a process of degradation of carbonaceous material (wood wastes) under controlled air or pure oxygen at a high temperature of l000 °C. As a result of gasification, high amount of gases are produced. Biomass gasification is done in gasifiers designed in various ways. Gasifiers are generally classified based on the physical conditions of the feed stocks in the gasifiers. These include fixed bed gasifier, stired bed gasifier, tumbling bed gasifier, fluidized bed gasifier. (FOE, 2009).

The vapours of the volatile matters that are formed during the distillation process subsequently condensed to tar, methanol, acetic acid, methyl acetate, oil and gas. Charcoal is used as a fuel, source of carbon in making carbon-di-sulphide. Methanol is used as a solvent and an antifreeze for automobiles. Acetic acid is used as a raw material for the manufacture of acetic anhydride, sodium acetate, cellulose acetate, ethyl acetate, and butyl acetate among other applications. Methyl acetate is a solvent used in paint industry. A product of tar known as "pitch" is used as rubber softener. Oils are used as solvent and insecticide. Gases are used as fuel for heating wood distillation and fuel for boilers (http://www.world-agriculture.com, Nan *et al*., 1994).

In the course of gasification, a number of chemical reactions take place. As soon as the biomass is ignited four distinct zones are set-up in the gasifier-unit. Biomass when introduced into the gasifier, enters into drying zone where the temperature is 200 - 400 °C. The products of this zone are vapours of tar, organo-chemicals, and liquid oils. (Guo, 2004). After drying zone it enters the pyrolysis zone, of temperature 400 – 750 °C. Pyrolysis at this point results in char, organic liquids and some gases. At 750 - l000 °C, mainly gases like carbon-di-oxide, carbon mon- oxide, hydrogen, methane etc. are produced and this stage is called as gasification zone. The oxidation zone which is at l000 - l400 °C also produces gases like nitrogen, carbon-di-oxide and hydrogen. (Shah *et al*., 1989; Guo, 2004.). When the process of oxidation is over, with the steam treatment, ash, an inert material is formed. The gasification process, thus, ultimately results in a number of gases which are in mixture. This mixture of gases is referred to as producer gas. Producer gas somewhat burnt like a natural gas which can be used as a fuel for engines. The composition is given in Table 3.2.

Table 3.2: Composition of Producer Gas.

S/No	Components of producer gas	Percentage Composition
1	Carbon monoxide	20 – 22
2	Hydrogen	15 – 18
3	Methane	2 – 4
4	Carbon-di-oxide	9 – 11
5	Nitrogen	50 – 53

Source:http://www.world-agriculture.com/

3.4.5 Anaerobic Biogasification

Degradation of organic matter in the absence of air to methane and carbon-di-oxide is called anaerobic biogasification. In villages, cattle manure is used as a fuel for cooking purposes. Consequently, preparation of biogas has become popular among rural people. Biogas can be utilized for cooking, lighting, operating diesel engines, water pumps etc. Animal wastes such as cattle dung, chicken droppings, and night soils are the main raw material for the production of biogas. The main advantages of the biogasification are that the biogas production can be started by constructing permanent structures such as tanks at a convenient place at home (Plöchl et al., 2009, Heiermann *et al*., 2009). It can be manufactured with least maintenance. Initial investment is also cheap. Gober gas or biogas

contains 60 per cent methane and 40 per cent carbon-di-oxide. The digested manure contains 1.5 - 2 per cent nitrogen and other soil nutrients, which can be used as an organic fertilizer. The biogas can be easily purified to methane which is an enriched fuel gas of high calorific value.

3.4.6 Fermentation and Distillation

The materials for alcoholic fermentation to produce ethanol are Sugary, Starchy and Lignocellulosic materials. The first two categories are first generation energy crops and the third category is referred to as the second generation energy crop.The sources of cellulose and lignocellulosic materials are the agricultural wastes and wood. All these categories are in abundant distribution in Nigeria. Nigeria being traditional agro-based country with the soil conditions that support production of diverse types of feedstocks for production of biofuels. Biofuel is a transportation fuel in the form of ethanol.

Ethanol is an alcohol fuel made from the sugars found in grains, such as corn, sorghum, and wheat, as well as potato skins, rice, sugar cane, sugar beets, and yard clippings. Researchers are experimenting with "woody crops", mostly small poplar trees and switchgrass, to see if they can grow them cheaply and abundantly to avoid total dependency on food crop. Any gasoline powered engine can use E10, that is a mixture of 10 per cent ethanol and 90 per cent gasoline. Only specially made vehicles can run on E85, a fuel that is 85 per cent ethanol and 15 per cent gasoline.

There are two major treatments that are necessary after the pretreatment operations. These are fermentation and distillation. Fermentation is to convert the larger, complex dextrose molecules into smaller, simple sugar molecules called maltose and glucose.

Once the mash's sugar is fermented by yeast, then the fermented liquid product is put into a still where it is heated for distillation. Distillation can happen because water boils at 100 °C and ethanol boils at 78 °C hence, ethanol can distill out and leave most of the water behind. (http://www.ethanolrfa .org/industry/statistics/#E). Ethanol production in Nigeria is still limited to application in beverages, allied and pharmaceutical industries.

3.4.7 Transesterification of Vegetable Oil

The basic treatment in the production of biodiesel is referred to as transesterification. This process is achieved in four principal stages as follows: pre-treatment of feedstock, transesterification, methyl ester purification and glycerol purification. Pretreatment of feedstock is to remove contaminants and components that will be detrimental to subsequent processing steps. Transesterification is the reaction process followed by the separation of the methyl ester and glycerol. Methyl ester purification stage is to remove the excess methanol, catalyst and glycerol from the transesterification process. Also at this stage the methanol removed is recycled to the transesterification process. The g**lycerol obtained is** further processed to remove impurities such as catalyst and methyl esters that are contained in order to produce a higher grade glycerol if economics dictate. Figure 2.4 presents the flow

chart of the biodiesel process.

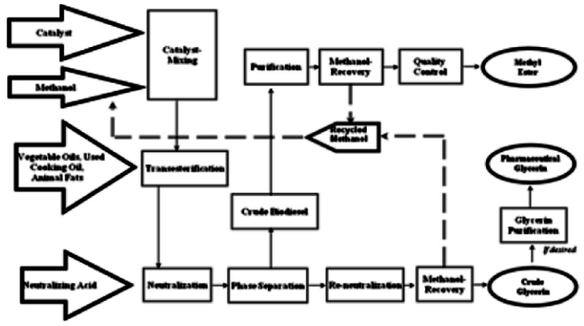

Fig 2.4: Schematics of Biodiesel processing

Biodiesel is a fuel made with vegetable oils, fats, or greases - such as recycled restaurant grease. Biodiesel fuels can be used in diesel engines without changing them. It is the fastest growing alternative fuel in the United States. Biodiesel, a renewable fuel, is safe, biodegradable, and reduces the emissions of most air pollutants. (Wood, 1993, http://journeytoforever.org/biodiesel)

3.5 Advantages of Biomass as Energy Source

Rural economic development in both developed and developing countries is one of the major benefits of biomass. The new incomes for farmers and rural population improve the material welfare of rural communities and this might result in a further activation of the local economy. Braun and Pachauri, 2008, Von Braun *et al.*, 2008, **Arndt *et al.*, 2008**). This new market diversification will provide farmers with stable income, and strengthen the local economy by keeping income recycling through the community. In the end, this will mean a reduction in the emigration rates to urban environments, which is a very common situation in many areas of the world.

The number of jobs that can be created through the production chains of biomass would be enormous. For instance, investigation revealed that 17,000 jobs can be created per every million of gallons of ethanol produced. About 50 million acres of land would be required to produce 5 quadrillion Btu's (British Thermal Units) of electricity. These would increase overall farm income tremendously (Von

The use of biomass energy has many environmental benefits. It can help mitigate climate change, reduce acid rain, soil erosion, water pollution and pressure on landfills, provide wildlife habitat, and help maintain forest health through better management. Biomass-energy systems can increase economic development without contributing to the greenhouse effect since biomass is not a net emitter of CO_2 to the atmosphere when it is produced and used sustainably. It also has other benign environmental attributes such as lower sulphur and NOx emissions and can help rehabilitate degraded lands **(Arndt et al., 2008).** There is a

growing recognition that the use of biomass in larger commercial systems based on sustainable, already accumulated resources and residues, can help improve natural resource management.

Biomass is generally and wrongly regarded as a low-status fuel, and in many countries rarely finds its way into statistics. It offers considerable flexibility of fuel supply due to the range and diversity of fuels which can be produced. Biomass energy can be used to generate heat and electricity through direct combustion in modern devices, ranging from very-small-scale domestic boilers to multi-megawatt size power plants electricity (e.g. via gas turbines), or liquid fuels for motor vehicles such as ethanol, or other alcohol fuels.

Biomass can be adopted for generation of energy. If the energy is properly utilized it will meet a sizeable percentage of the country's demands for fuel as well as energy. A and forest residues can be collected to produce fuels, organic manures and chemical feed stock. Waste from urban and industrial locations can be converted to fuel in boilers and as a feedstock for producing methane and some liquid fuels. Some specific energy plants could be cultivated for use as energy feed stock and cultivation of commercial forestry, aquatic and marine plants for different products. Thus production of biomass helps in developing cheaper source of energy from unutilized agricultural residues, wastes, forest wastes, plantations etc. which is an **alternative source of energy** for fossil fuel energies.

3.6 Production of Biofuel and Food Security

A major criticism often levelled against biomass, particularly against large-scale fuel production, is that it could divert agricultural production away from food crops, especially in developing countries. The basic argument is that energy-crop programmes compete with food crops in a number of ways (agricultural, rural investment, infrastructure, water, fertilizers, skilled labour etc.) and thus cause food shortages and price increases. However, this so-called 'food versus fuel' controversy appears to have been exaggerated in many cases.

The subject is far more complex than has generally been presented since agricultural and export policy and the politics of food availability are factors of far greater importance. The argument should be analysed against the background of the world's (or an individual country's or region's) real food situation of food supply and demand (ever-increasing food surpluses in most industrialized and a number of developing countries), the use of food as animal feed, the under-utilized agricultural production potential, the increased potential for agricultural productivity, and the advantages and disadvantages of producing biofuels.

Generally, there are obvious factors that may lead to food shortage and price increase beside production of biofuel from biomass. These factors include combination of policies which were biased towards commodity export crops and large acreage increases of such crops, hyper-inflation, currency devaluation, and price control of domestic foodstuffs. Developing countries are facing both food and fuel problems. Adoption of appropriate agricultural practices is necessary to be able to ultilise available land and other resources to meet both food and fuel needs.

1.0 Summary

Various types of biomass were highlighted as forms of alternative energy. The energy potential of these important commodities were examined. The benefit of biomass is not limited to energy source but it could lead to increase in farm income and market diversification, reduction of agricultural commodity surpluses and derived support payments. Biomass development can enhance international competitiveness, revitalization of retarded rural economies, and reduction of negative environmental impacts. The reduction of negative environmental impacts is most important issues related to utilisation of biomass as energy source. The environmental benefits of biomass were discussed and some of the environmental benefits include ability to mitigate climate change, reduce acid rain, soil erosion, water pollution and pressure on landfills, provide wildlife habitat, and help maintain forest health through better management. Biomass-energy systems can increase economic development without contributing to the greenhouse effect. The processes involved in conversion of biomass to various sustainable energy products were highlighted with their unique characteristics. The issues related to energy crop and food security were presented and obvious factors that may lead to food shortage and price increase beside production of biofuel from biomass were highlighted and it was concluded that adoption of appropriate agricultural practices is necessary to be able to ultilise available land and other related natural resources to meet both food and fuel needs for biomass utilization.

5.0 Self-Study Questions

i. What is a biomass?
ii. List four benefits of biomass as a source of energy
iii. State five methods for transforming biomass to renewable energy
iv. Identify two challenges of biofuel production in developing countries

6.0 Tutor Marked Assignment

1. Identify the various stages in transformation of Biomass to Renewable Energy and discuss in details the products and by products of the following processes:
    a) Combustion
    b) Pyrolysis
    c) Destructive Distillation
    e) Gasification
    f) Anaerobic Biogasification
    g) Fermentation and Distillation
    h) Transesterification of Vegetable Oil

2. With the aid of Schematics diagram present the processing flow diagram of
    a) Biodiesel processing
    b) Biofuel processing
3. Use appropriate diagram to illustrate production of biogas in a biogas digester with the blend of a cow dung and green vegetable matter as the substrate.

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Module Five

APPLICATIONS OF BLOOD GROUP SYSTEMS AND DNA FINGER PRINTINGS

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INTRODUCTION

Human being is a unique creature. Its uniqueness lies in the unit of inheritance called DNA (deoxy ribonucleic acid), present in all the body cells and is the basis of variability among individuals. The chemical structure of everyone's DNA is the same. The only difference between people (or any animal) is the order of the chemical components of DNA known as base pairs which consist of four compounds, adenine, guanine, cytosine and thymine. Although 99 % of all DNA in every human body are the same, the remaining 1 % is unique to each individual. On this basis, identification of every individual is made possible. These variations are the underlying principles for most of the applications of blood group and DNA fingerprinting.

Learning Outcomes

By the end of this module, you should be able to:

(i) state the essence of the human DNA;
(ii) understand the underlying principles for most of the blood group and DNA fingerprinting applications;
(iii) state the most important classifications to describe blood types in humans;
(iv) define blood transfusion; the ABO system and the Rhesus factor (Rh factor) systems;
(v) state the various applications of DNA fingerprinting;
(vi) state the applications of tandem repeats

Main Body

Introduction

The module introduces you into the rudiments of the blood group systems, the DNA fingerprinting and their various applications. This unit is divided into two units as follows:
Unit 1 Blood Group System
Unit 2 DNA Fingerprinting

UNIT 1: BLOOD GROUP SYSTEM

Contents

1.0 Introduction

This study unit introduces you to the various blood group system, the rhesus blood group and their uses vis-à-vis transplanting, organ transplants and paternity testing.

2.0 Learning Outcomes

By the end of this unit, you should be able to:

i. Explain Blood group systems
ii. Identify the various four blood groups
iii. Explain the Rhesus Blood group
iv. Uses of the ABO and Rhesus Blood groups

3.0 Main Content

3.1 Blood group systems

"Blood group" is used to refer specifically to a person's ABO status, while "blood type" refers to both ABO and Rh factors. The two most important classifications to describe blood types in humans are ABO and the Rhesus factor (Rh factor). There are 46 other known types in humans, most of which are rarer than ABO and Rh.

The ABO classified blood into four groups, **A**, **B**, **AB** and **O** while the rhesus classified it as positive or negative. However, this classification is based on the presence of specific molecules, called antigen on the surface of red blood cells.

The human body is so discriminative that it only accepts substances with structures similar to its own. For instance, it tends to reject incompatible blood groups when transfused and this may leads to many pathological conditions including haemolytic anaemia (lysis of the blood cells), kidney failure, shock, and even death.

Blood transfusion is the intravenous replacement of lost or destroyed blood. The blood given in the transfusion must be of the correct type, one that matches the patient group; otherwise the tissues reject the new blood by forming a clot. Tissues generally reject any foreign body and a transfusion of blood can, if of the wrong groups, be taken as a foreign body. The ABO blood types also exist among chimpanzees and baboons.

The absence of recognizable antigen type (A and B) on the surface of the RBC leads to production of defence (called antibody) by the body against such blood cell and hence, immediate destruction of the infused blood. The breakdown products cause acute medical illness; hence, it is of, quite literally, vital importance that the blood types of the donor and receptor are properly matched.

3.2 The 'ABO' System

There are four groups in the ABO blood grouping system; they include blood group 'A', 'B', 'AB' and 'O'. The RBC of these groups contain the corresponding antigens, A, B, A and B and neither A nor B respectively. Along with these antigens, the blood also contain antibodies as defence against non-matching antigens; the anti-A and anti-B.

Blood group A: This group contains antigen A in their blood cells and antibody anti-B in their
plasma. People with blood group 'A' can receive and give blood to people with blood group 'A'
only (provided they are compatible for Rh factor).
Blood Group B: This group contains antigen B in their blood cells and antibody anti-A in their
plasma. People with blood group 'B' can receive and give blood to people with blood group 'B'
only (provided they are compatible for Rh factor)
Blood Group AB: This group contains both antigens A and B in their blood cells and none of the antibodies in their plasma. People with blood group 'AB' are known as “universal recipients”
as they can receive blood from any person belonging to any of the ABO group (with matching rhesus status). Thus people with AB blood type can receive blood from people with blood group 'A', 'B', 'AB' or 'O' (however, compatibility with other antigens like rhesus needs to be matched).
Blood Group O: This group contains none of the antigen ('A' or 'B' in their blood cells but contain both the antibodies (anti A and anti-B) in their plasma. People with blood group 'O' are known as “universal donors”, as they can donate their blood to a person belonging to any of the 'ABO' group (with matching rhesus status).
Thus people with 'O' blood type can donate blood to people with blood group 'A', 'B' 'AB' or 'O' (however, compatibility with other antigens like rhesus needs to be matched).

3.3 The Rhesus Blood Group

Like the ABO system, rhesus blood grouping is also classified based on the red blood cell surface antigen designated by the letters Cc, Dd, Ee and Ff.

The letters denote **allelomorphic** genes which are present in all cells except the sex cells where a chromosome can carry C or c, but not both. In this way, the Rhesus genes and blood groups are derived equally from each parent.

When the cells contain only the cde groups, then the blood is said to be Rhesus negative (Rh -ve); when the cells contain C, D or E singly or in combination with cde, then the blood is Rhesus positive (Rh +ve).
Matching the Rhesus factor is very important, as mismatching (an Rh positive donor to an Rh negative recipient) may cause the production in the recipient of an antibody to the Rh(D) antigen, which could lead to subsequent haemolysis.

This is of particular importance in females of or below childbearing age, where any subsequent pregnancy may be affected by the antibody produced. For one-off transfusions, particularly in older males, the use of Rh(D) positive blood in an Rh(D) negative individual (who has no atypical red cell antibodies) may be indicated if it is necessary to conserve Rh(D) negative stocks for more appropriate use. The converse is not true: Rh +ve patients do not react to Rh -ve blood.
Rh disease occurs when an Rh negative mother who has already had an Rh positive child (or an accidental Rh +ve blood transfusion) carries another Rh positive child. After the first pregnancy, the mother immune system is sensitized against Rh +ve red blood cells, such that during the second Rh +ve pregnancy, an antibody (known as immunoglobulin G) is produced which can cross the placenta and haemolyse the red cells of the second child. This reaction does not always occur, and is less likely to occur if the child carries either the 'A' or 'B' antigen and the mother does not. In the past, Rh incompatibility could result in stillbirth, or in death of the mother, or both.

Rh incompatibility was until recently the most common cause of long term disability in the United States. At first, this was treated by transfusing the blood of infants who survived. At present, it can be treated with certain anti-Rh +ve antisera, the most common of which is *Rhogam* (*anti-D*). It can be anticipated by determining the blood type of every child of an RhD -ve mother; if it is Rh +ve, the mother is treated with anti-D to prevent development of antibodies against Rh +ve red blood cells.

3.4 Uses of ABO and Rhesus Blood Groups

a. **T**ransfusion: Identification of match blood group is important before transfusion. Based on this, blood can be classified generally into eight groups A+, B+,AB+, O+, A-, B-, AB- and O-. Correct matching for the ABO system is vital. An individual with either of the blood group A+, B+, A-, B- can only receive blood carrying the same antigen. However, AB can receive from any of the group since it has the two A and B antigen while a person with O blood group donate to anybody due to the lack of the antigens; thus are recognized as 'self'.

Rh-negative persons transfused with Rh-positive blood will make anti-D antibodies from 50 to 75 percent of the time. Antibody made in response to a foreign red cell antigen is usually not harmful but does require subsequent transfusions to be antigen-negative. Rh-positive blood should never be given to Rh-negative females before or during the childbearing age unless Rh negative blood is not available and the transfusion is lifesaving. If such a woman

subsequently became pregnant with an Rh-positive foetus, she might form anti-Rh antibody, even though the pregnancy was the first, and the child might develop *erythroblastosis fetalis* (haemolytic disease of the newborn).

b. Organ transplants: The ABO antigens are widely distributed throughout the tissues of the body. Therefore, when organs such as kidneys are transplanted, most surgeons prefer to use organs that are matched to the recipient's with respect to the ABO antigen system, although the occasional survival of a grafted ABO-incompatible kidney has occurred.

c. Paternity testing: Although blood group studies cannot be used to prove paternity, they can provide unequivocal evidence that a male is not the father of a particular child. Since the red cell antigens are inherited as dominant traits, a child cannot have a blood group antigen that is not present in one or both parents. For example, if the child in question belongs to group 'A' and both the mother and the putative father are group 'O', the man is excluded from paternity. By using multiple red cell antigen systems and adding additional studies on other blood types (HLA [human leukocyte antigen], red cell enzymes, and plasma proteins), it is possible to state with a high degree of statistical certainty that a particular male is the father.

4.0 Summary

The two most important classifications to describe blood types in humans are ABO and the Rhesus factor (Rh factor). There are 46 other known types in humans, most of which are rarer than ABO and Rh. The ABO classified blood into four groups, **A**, **B**, **AB** and **O** while the rhesus classified it as positive or negative. Some uses of the ABO and Rhesus Blood Groups include, transfusion, paternity testing and organ transplanting.

5.0 Self-Assessment Questions

1. State the most important classifications to describe blood types in humans;
2. Define blood transfusion;
3. Differentiate between "blood group" and "blood type";
4. Describe the ABO and the Rhesus factor (Rh factor) systems;
5. Explain the various classes of the ABO system;
6. Differentiate between the various blood groups;
7. State the importance of the Rhesus factor in females of or below childbearing age;
8. Enumerate the various uses of ABO and Rhesus Blood Group;
9. Explain the importance of ABO system in organ transplant;
10. Classify blood on the basis of blood transfusion;

7.0 Tutor Marked Assessment

i. Give two differences between the blood groups AB and O.
ii. What is the similarity between blood groups AB and B?
iii. In what order is the commonness of the blood types?

8.0 Further Reading

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Unit 2: DNA Fingerprinting

Contents

1.0 Introduction

This study unit familiarizes you to the concept of DNA fingerprinting technology and their uses vis-à-vis diagnosis of inherited disorder, developing cures for inherited disorders, paternity and maternity, etc.

2.0 Learning Outcomes

By the end of this unit, you should be able to:

i. state the essence of the human DNA;
ii. highlight the basis of variations among individuals;
iii. explain how the identification of every individual on the basis of DNA is possible;
iv. enumerate the four laboratory steps involved in DNA fingerprinting;
v. state the various applications of DNA fingerprinting;

3.0 Main Contents

3.1 DNA Fingerprinting

The characteristics of all living organisms including humans are essentially determined by information contained within DNA (deoxyribonucleic acid) that they inherit from their parents.

Each person has a unique DNA fingerprint like the fingerprints that came into use by detectives and police laboratory during the 1930s. Unlike conventional finger print that occurs only on the finger tips and can be altered by surgery, a DNA fingerprint is the same for every cell and therefore every part of the body of a person. It cannot be altered by any known treatment. Consequently, DNA fingerprinting is rapidly becoming the primary method for identifying and distinguishing among individual human beings.

The molecular structure of DNA can be vividly described as a zipper with each tooth represented by one of four letters A, C, G or T, coding for adenine, cytosine, guanine and thymine respectively with opposite teeth combining to form an A-T or G-C pairs.

The information contained in DNA is determined primarily by the sequence of the letters along the zipper. Therefore, two DNAs having the same composition but in different sequence present different information. For example, the sequence ACGCT represents different information than the sequence AGTCC in the same way that the word "POST" has a different meaning from "STOP" or "POTS", even though they use the same letters. The characters of a human being are the result of information contained in the DNA code.
There are so many millions of base pairs in each person's DNA with a different and unique sequence. Using these sequences, every person could be identified solely by the sequence of their base pairs. However, because there are also many millions of base pairs, the task would be very time-consuming. Instead, scientists are able to use a shorter method, because of repeating patterns in DNA. These patterns do not, however, give an individual "fingerprint", but they are able to determine whether two DNA samples are from the same person, related people, or non-related people.

3.2 Steps in laboratory procedure for DNA fingerprinting

Living organisms that look different or have different characteristics also have different DNA sequence. The more varied the organisms, the more varied the DNA sequences. DNA fingerprinting is a laboratory procedure that requires four steps namely:

1. **Isolation of DNA**: DNA must be recovered from the cells or tissues of the body. Only a small amount of tissue, (blood, hair, or skin) is needed. The amount of DNA found at the root of one hair strand is usually sufficient.
2. **Cutting, sizing and sorting**: Special enzymes called restriction enzymes are used to cut the DNA at specific places. The DNA pieces are sorted according to size by a sieving technique called electrophoresis. The DNA pieces are passed through a gel or a jelly-like product made from seaweed (agarose).
3. **Transfer of DNA to nylon**: The distribution of DNA pieces is transferred to a nylon sheet by placing the sheet on the gel and soaking them overnight.
4. **Probing**: Adding radioactive or coloured pobes to the nylon (nitrocellulose paper) sheet produces a pattern called the DNA fingerprint. Each probe typically sticks in only one or two specific point(s) on the nylon sheet. This method of probing is known as hybridization. The final DNA fingerprint is then built by using several probes (5-10 or more) simultaneously.

3.3 Uses of DNA fingerprinting

DNA fingerprints are useful in several applications of human health care research and the justice system:

a) **Diagnosis of inherited disorder**: DNA fingerprinting is used to diagnose inherited

disorders in both parental and new-born babies in hospitals around the world. These disorders may include cystic fibrosis, haemophilia, sickle cell anaemia and others. Early detection of such disorders enables medical practitioners and the parents for proper treatment of the child. Genetic counsellors use DNA fingerprint information to help prospective parents understand the risks of having an affected child and in their decision concerning affected pregnancies as well as marriages.

b) **Developing cures for inherited disorders**: Research programmes aimed at locating inherited disorders on the chromosomes depend on the information contained in DNA fingerprint. By studying the DNA fingerprints of relatives who have history of some particular disorder, or by comparing larger groups of people with and without the disorder, it is possible to identify DNA patterns associated with the disease in question. This is a necessary first step in designing and eventual genetic cure for these disorders.

c) **Paternity and maternity**: Each individual is characterized by arrays of DNA sequence inherited from his/her parent. Although some sequences may be common between individuals, some are unique to a particular line, particularly, those involving repetition of sequence (e.g. CAGCAGCAGCAG). Such repeated DNA sequence is known as tandem repeats. It describes a pattern that helps determine an individual's inherited traits. Because a person inherits his or her tandem repeats from his/her parents, the patterns of the tandem repeats can be used to establish paternity and maternity. The patterns are so specific that a parental tandem repeats pattern can be reconstructed even if only the children's repeats patterns are known.

d) **Criminal identification and forensic**: DNA isolated from blood, hair, skin, cells or other genetic evidence left at the scene of crime can be compared, through their tandem repeats patterns, with the DNA of a criminal suspect to determine guilt or innocence. Tandem repeats patterns are also useful in establishing identity of a homicide victim, either from DNA found as evidence or from the body itself.

e) **Personal identification**: Since tandem repeats is unique to a particular individual or family line, it does allow for identification of an individual or member of a family.

4.0 Summary

The successful applications of DNA finger prints would change the relations between criminals and victims in unpredictable ways. Obviously, adding a powerful new weapon to the arsenal of the law will increase rate of detection and conviction, removing dangerous people from circulation-and, we should remember, it will also prove valuable in clearing the innocent. Yet it will be naive to think that criminals will remain passive in the face of the new technology, or that the prospect of inevitable capture and incarceration will stay their hands. Helpful though blood groupings and DNA finger prints may be, it is not a panacea.

5.0 Self-Assessment Questions

i. State 3 importance of the DNA code.
ii. What are the laboratory steps required for a successful DNA fingerprinting?
iii. Give 4 uses of DNA fingerprinting

6.0 Tutor Marked Assessment

1. Differentiate between DNA fingerprint and the conventional fingerprint that occurs only on the finger tips.
2. To what use do scientists put repeating patterns in DNA?

7.0 Further Reading

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Module Six

MEDICINAL PLANTS: MYTHS, FACTS, CONSERVATION AND TISSUE CULTURE TECHNIQUES

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INTRODUCTION

Traditional medicine according to WHO (2003), refers to health practices, approaches, knowledge and beliefs incorporating plant, animal and mineral based medicines, spiritual therapies, manual technologies and exercises, applied singularly or in combination to diagnose, treat and prevent illnesses or maintain well-being. Traditional medicine has received renewed attention in the last decade, maintained its popularity in all regions of the developing world and its use is rapidly spreading in industrialized countries. Herbal medicine is the act or practice of using herbs, herbal preparations including extracts to maintain health and to alleviate or cure diseases therapy. A medicinal herb or simply herb is a plant or plant part valued for its medicine, aromatic or savory qualities. Today, most of the people in Nigeria rely on herbal medicine for their health care needs since they are generally more accessible and affordable. As a result, there is an increasing trend, worldwide, to integrate herbal medicine into the primary health care system. World Health Organization (WHO) estimates that 4 billion people (representing 80% of world population) presently living in developing countries of the world rely on herbal medicinal products as primary source of healthcare and traditional medical practice. The world health organization in 2004 noted that of 119 plant-derived pharmaceutical medicines, about 74% are used in modern medicine in ways that correlated directly with their traditional uses as plant medicines by native cultures.

Learning Outcomes

By the end of this module, you should be able to:

(i) understand general aspects of Traditional Medicine and Herbal Medicine;
(ii) identify medicinal plants and some examples;
(iii) reasons for increasing use of medicinal plants;
(iv) advantages and disadvantages of using medicinal plants;
(v) myths and facts about medicinal herbs;
(vi) introduction to conservation of medicinal plants; and
(vii)plant tissue culture techniques;

Main Body

Introduction

The module introduces you into the essentials of medicinal plants, its myths, facts,

conservation and tissue culture techniques. This unit is divided into two units as follows:

Unit 1 Medicinal Plants: Myths and Facts
Unit 2 Medicinal Plants: Conservation and Tissue culture techniques

Unit 1: Medicinal Plants: Myths and Facts

Contents

1.0 Introduction

This study unit introduces you to the definition of medicinal herbs while differentiating the myths from the facts. The unit will focus particularly on the reasons for the increasing use of medicinal herbs while enumerating their advantages from the disadvantages.

2.0 Learning Outcomes

By the end of this unit, you should be able to:

i. Define medicinal plants
ii. Differentiate the myths from the facts about these compounds
iii. Enumerate the advantages and disadvantages of their use.

3.0 Main Content

3.1 What are Medicinal herbs?

A medicinal herb is any plant which contain substances in its root, stem, leaf, fruit or flower that can be used for therapeutic purposes or which are precursors for the synthesis of useful drugs. They have similar properties as conventional pharmaceutical drugs. These plants can be in the form of food, spices, perfumery plants, microscopic plants like fungi, actinomycetes (for isolating drugs like antibiotics), fibre plants (e.g. cotton, flax, and jute,

used for preparing surgical dressings). Medicinal plants have been identified and used from prehistoric times.

Botanical names	Local names	English names	Parts used	Traditional uses	Preparations
1. *Abrusprecatorius*	Oju-ologbo (Y), Otoberebere (I), Idonzakara (H)	Crab's eye, Bead tree, Indian liquorice	Leaves, Seeds, Roots	Cough Hasten labour Convulsion , Conjunctivitis Contraceptives, Improve fertility	Root extract Seed infusion Powdered leaves Boiled powdered seeds
2. *Azadirachtaindica*	Dongoyaro (H), Eke-oyibo (Y)	Neem tree, Margosa	Leaves, Seed, Stem bark	Malaria fever Septic boil Anthelmintic, Syphilis, Antipyretic Piles, Urinary disease	Leaf and stem bark decoction Leaf poultice Root bark decoction Ripe fruits
3. *Bambusa vulgaris*	Oparun (Y), Iko (Bini), Atosi (I)	Common Bamboo	Leaves, Young shoot	Emmenagogue Abortifacient, Respiratory diseases Appetizer, Cleaning of wounds	Leaf decoction Cooked young shoot Poultice of young shoot
4. *Carica papaya*	Ibepe (Y), Qwanda (H), Ojo (I)	Pawpaw	Leaves, Fruits, Seeds, Roots	Malaria fever Antipyretic Diabetes Gonorrhoea,] Syphilis,] Amoebic] dysentery] Diuresis, Laxative Abortifacient Galactagogue, Mild convulsion	Boiled leaves Cold infusion of leaves Leaf decoction and *Xylopiaaethionica*fruits Fresh leaves Unripe fruits Cooked unripe fruits Cooked ripe fruits with melon
5. *Chromolaenaodoratum*	Akintolataku (Y), Ewe Awolowo (Y)	Siam weed	Leaves	Dysentery, Malaria fever, Male contraceptive Headache, Toothache, Antimicrobial	Leaf infusion Leaf is chewed
6. *Fadogiaagrestis*	Bakingaigai (H)	Black aphrodisiac	Stem	Erectile dysfunction	Water extract of the stem
7. *Massulariaacuminata*	Pakoijebu (Y), Orin ijebu (Y)	Chewing stick	Stem, Stem bark, Root	Aphrodisiac, Anticancer, Lumbago, Eye ointment, Coughs, Mental sickness Chewing stick	Decoction and infusion of stem bark and root Sliced stem
8. *Musa paradisiacal*	Ogede, Agbagba (Y), Ayaba (H), Ogadejioke (I)	Plantain	Leaves, Leaf juice, Leaf sap, Fruit	Fresh wounds, Cuts, Insect bite Abortifacient Diarrohoea, Dysentery, Epilepsy Breast enlargement Tonic, Gonorrhoea, Goitre Aphrodisiac, Diuretic, Dysentery	Leaf juice Chewing of leaves Leaf sap Leaves tied to the breast Juice from the root Fruit
9. *Ocimumgratissimum*	Efinrinajase (Y), Nehonwu (I), Aaidoya ta gida (H)	Tea Bush	Leaves, Stem, Whole herb	Prevention of miscarriages Cough, Cold, Fever, Chest pain, Diarrhoea Convulsion, Colic pains	Ground fresh leaves with alligator pepper (*Aframomomummelequeta*) and applied to lower abdomen of pregnant women Decoction of stem and leaves Cold infusion of the herb
10. *Vernonia amygdalina*	Ewuro (Y), Shiwaka (H), Olubu (I)	Bitter leaf	Leaves, Root, Stem	Diabetes Pneumonia Laxative, Anitpyretic Stomachache	Leaf extract Leaf decoction Root decoction Chew stem

Key: Y=Yoruba; H=Hausa; I=Igbo
Adapted from Gill (1992)

3.1.1 REASONS FOR THE INCREASING USE OF MEDICINAL HERBS

People use medicinal herbs for several reasons and these include:

1. **Less expensive and safer** - Most Nigerians especially those living in rural communities don't have free access to orthodox medicine. Where such exist, the rising cost of imported medicines has posed a big problem.
2. **Dissatisfaction or lack of efficacy of conventional therapies -** Some parents take to herbs because of perception that prescription drugs are not effective against their children's chronic problems, poor outcomes from conventional therapies, limited treatment options for a serious illness and lack of satisfaction with synthetic drugs.

3. **Involvement in the decision-making process -** Some people choose medicinal herbs simply because they have confidence in the herb sellers or herbalists and are able to interact more freely with them.
4. **Traditional/Cultural or spiritual preference** - Many rural communities have great faith in traditional medicine, particularly the herbs because they believe that it is the wisdom of their fore-fathers. Medicinal herbs are therefore used on the advice and information obtained from relatives and friends.

5. **Significant side effects of conventional therapies -** The side effects of modern medicines of synthetic origin such as headache, hypertension and even sudden cardiac failure as with some drugs like yohimbine and Viagra, may force people to look for herbs as alternative.
6. **Believe that herbal products are superior to orthodox drugs -** This is because natural medicine is now seen as the last hope of many people including those in the developed countries of the world like USA, Canada, Asia and Europe. Most users perceived that herbs are efficacious than conventional medicine.

3.1.2 ADVANTAGES AND DISADVANTAGES OF HERBAL MEDICINE

The advantages and disadvantages of herbal medicine are as follows:

Advantages

The advantages of using herbal medicines include:

1. Reduced risk of side effects
2. Effectives with chronic conditions
3. Reduced cost
4. Widespread availability

Disadvantages

Herbs are not without disadvantages, and herbal medicine is not appropriate in all situations.

1. Inappropriate for many conditions
2. Lack of dosage instructions
3. Poison risk associated with wild herbs
4. Medication interactions
5. Lack of regulation

3.2 MYTHS AND FACTS

Myths on herbs are popular beliefs or stories that are associated with medicinal plants especially one considered to illustrate cultural ideal. It is also an idea or explanation which is widely held but untrue or unproven. Myth is often interchangeable with legend or allegory and may be associated with religious/cultural beliefs, feelings or practice. On the other hand, facts are things that are known and proved to be true. Several myths and facts have been told about medicinal herbs, but the most common ones are as described:

1. **Herbal efficacy -** Herbs have been used by all cultures throughout history. Indeed,

many drugs today are of herbal origin. Several laboratories have reported the effectiveness of common indigenous medicinal herbs against array of diseases. Research has provided scientific evidence to the acclaimed sex enhancing potentials of *Fadogia agrestis* (Barkin gaigai-Hausa) stem. Experimental evidence has also showed that *Massularia acuminata* (pako ijebu/orin ijebu-Yoruba) has antibacterial potentials, thus justifying its use as chewing stick in traditional medicine. Numerous other diseases or complaints such as hernia, snake bite, arthritis, gout etc. have been treated using herbs alone or a mixture of medicinal plants with animal parts. All these have clearly supported the fact that medicinal plants are indeed efficacious. If however, they are not, herbal medicine and medicinal plants would have gone into extinction.

2. **Multiherbal therapy-** Most herbalists/herb sellers use as many as between 6-14 plants for a given disease condition with claim that some herbs will reduce symptoms of the diseases while others will improve digestion and absorption of the remaining herbs; this practice has been going on from time immemorial in the folk medicine of several countries. In Nigeria, it is common among the rural population to combine several herbs which they claim to have particular curative properties, whereas only one or some of the combined herbs may be containing the active ingredient for curing particular diseases. This myth is indeed very true and could be regarded as a fact.

While the above may be true, many other herbal medicine advocates propose that the therapeutic benefit of herbal products stems from the synergistic action of several natural components in the herbs. Some constituents that are thought to be inactive may actually play a role in the pharmacokinetics of the active component.

3. **Safety-** How safe are these herbs? Many consumers use herbs on self-medication because there is a wide-held misconception that 'natural' means 'safe'. Many forget that herbs are drugs since they contain many chemicals. Just because something is 'natural' does not mean that one should be lured into a false sense of security. The myth in this regard is that plants commonly used in traditional medicine are assumed to be safe. This position is based on the long usage in the treatment of diseases according to knowledge accumulated over the centuries. However, the fact on safety of medicinal herbs is that researches have shown that many plants used as food or in traditional medicine are potentially toxic, affecting the normal functioning of the organs (organ dysfunction), selective and total adverse effect on the normal functioning of the blood, reducing sperm count and motility and inflicting infertility. Medicinal plants can also initiate the process of carcinogenesis that will eventually lead to cancer. Medicinal plants can cause photosensitivity, skin irritation, excessive daytime sleepiness, liver inflammation and interaction with anticlotting systems.

It is true that when these herbs are taken in prescribed quantity, most of them are 'safe', but indiscriminate use or its abuse is inimical to the health of consumer. Some of these herbs could even kill. A typical example is the case of a man who took an overdose of a sex-enhancing medicinal plant just because he wanted to satisfy his female partner only to result in premature death because for a long period of time, his

erect male organ did not return to the flaccid state. Besides, some of these herbs like Aloe (*Aloe vera*), mistletoe (*Viscum album*), Wild yam (*Discorea villosa*) might be dangerous during the first trimester of pregnancy as they may cause premature contractions that can lead to abortion and birth defects. Overdose of ginseng (*Panax ginseng*) can also lead to androgynous babies (babies with over stimulation of male sex hormones). It has been reported that toxic effects due to the use of herbs are usually associated with liver toxicity (hepatotoxicity). Other toxic effects on the kidney (kidney dysfunction), nervous system, blood and circulatory systems have also been published. Therefore, the fact that herbs are of natural origin does not mean that they are safe!

4. **Misidentification of herbs-** Medicinal plants which include barks, bulbs, stem and roots are dried and sold as semi and processed products. These products are seldom labeled but bulk stock may be identified in local names and packaging is rudimentary. The use of local names will not allow easy identification of medicinal plant products and desiccation through drying usually render taxonomic identification of the plants difficult.

   Poisoning from traditional medicine is usually a consequence of misidentification, incorrect preparation or inappropriate administration and overdose. Many cases of poisoning remain unrecorded, and mortality from traditional plant medicines may be higher than currently known. Demographic studies indicate that the majority of traditional medicine-related poisoning affect children.

5. **Herbal knowledge-** The safety of patients in traditional medicine is being compromised nowadays because a growing number of herb sellers or healers do not possess sufficient knowledge, skill and experience to practice successfully. At times, wrong diagnoses are made since there is no way to carry out laboratory tests. This results in misidentification and misadministration of medicinal herb. In addition, the love to make more money may be the consequence of purposeful adulteration; potentially toxic plants that are readily available may be added or substituted for the main active medicinal plant. Similarly, medicinal herbs that have become old in stock may be added to a recipe just to get rid of it without necessarily having a significant role in the recipe. All these are stories being told about medicinal plants and they are actually true.

6. **Quality control and standardization of medicinal herbs-** Due to reliance on medicinal herbs, there is the need in accordance with WHO to ensure quality control of these herbs and its standardization. There is the myth that standardization of herbs will reduce or eliminate the beneficial effects of such plants. This, however, is not true as some studies have refuted this. Again, the consumer has no way of knowing exactly the content and what effect the contents may have as against standard pharmaceutical drugs. Therefore, one cannot be sure of what he is getting because herbal products are not regulated nor are manufacturers responsible for proving the efficacy and safety of their remedies. Standardization should therefore be aimed at regulating the number of plants being put together for a particular disease. For instance, in the treatment of cholera, as many as four plants: Alligator pepper

(*Aframomum melegueta* seeds), common wild sorghum (*Sorghum arundinaceum* seeds), Bitter lemon (*Momordica charantia* leaves) and Ako ejirin-Yoruba anbd Ukwuani-Igbo (*M. cissoids* leaves) are needed. There is the need to actually reduce it to one or two that are actively involved in alleviating the disease condition. In addition, several of these herbs do not carry labels and when they do, some of the items listed may not be there and could be misleading. The labels also may not list the active ingredients, side effects, how it should be taken, the quantity (dosage) and frequency.

4.0 Summary

The use of herbs (medicinal plants) in the management of diseases is on the increase world wide and is becoming an integral part of the health care delivery system. This is due to its efficacies and reduced side effects which in some cases have been validated by scientific data. The use of these medicinal plants has been surrounded by myths in which some are true while others are not and should therefore be used with caution.

5.0 Self-Assessment Questions

1. The role of lemon grass in the multi-herbal treatment of malaria is ?
A. That it contains the active ingredient
B. It is a colorant
C. It is a flavouring agent
D. It increases urine excretion

2. There is a school of thought in herbalism that “natural” means “safe”.
A. True
B. False
C. Neither True nor False
D. None of the above

3. Indiscriminate use of plants is **NOT** inimical to the health of consumers
A. True
B. False
C. Neither True nor False
D. None of the above

4. The inability of the male copulatory organ to return back to the original flaccid state is known medically as
A. Erection
B. Arousal
C. Erectile dysfunction
D. Failure of detumescence

6.0 Tutor Marked Assessment

i. Define medicinal plants
ii. Enumerate any three myths about medicinal herbs
iii. Give any 3 advantages and disadvantages each of medicinal herbs usage.

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UNIT 2: MEDICINAL PLANTS: CONSERVATION AND TISSUE CULTURE TECHNIQUES

Contents

1.0 Introduction

This study unit introduces you to the conservation strategies involved in medicinal plants and the various techniques of plant tissue culture.

2.0 Learning Outcomes

By the end of this unit, you should be able to:

i. define the conservation of medicinal plants
ii. list the techniques involved in plant tissue culture

1.0 Main Content

3.1 Conservation of Medicinal plants

Medicinal plants are globally valuable sources of new drugs. The existence of these plants are being faced with several threats that include degradation of habitat due to expanding human activity, forest degeneration, destructive collection of plant species, invasion of exotic species that compete with native species, increased spread of diseases, industrialization, over-exploitation, human socioeconomic change and disturbance, changes in agricultural practices, excessive use of agrochemicals, natural and man-made calamities and genetic erosion, among others. Therefore, there is the need to do away with these threat of extinction to medicinal plants and conserve the botanicals.

Conservation of medicinal plants is the act by which the environment is managed in such a way to obtain the greatest value for the present generation and maintaining the potential of the herbs for the future. For most of the endangered medicinal plant species, no conservation action has been taken. For example, there is very little evidence of medicinal plants in the gene-banks. Also, too much emphasis has been placed on the potential of the medicinal plants for discovering new potent and novel drugs, and too little on the many problems involved in the use of traditional medicines by local populations. For most countries, there is not even a complete inventory of medicinal plants. Much of the knowledge on their use is held by traditional societies, whose very existence is now under threat. Little of this information has been recorded in a systematic manner. Furthermore, to meet the requirements of expanding regional and international markets healthcare products and needs of growing populations, large quantities of medicinal plants are harvested from forests. Specifically, in Nigeria, large number of medicinal plants is extracted from the wild to meet the increasing demand for raw materials needed for domestic consumption. As a result, the natural resources are rapidly depleting.

Conservation of biological diversity involves protecting, restoration and enhancing the variety of life in an area so that the abundance and distribution of species and communities contributes to sustainable development. The ultimate goal of conservation biology is to maintain the evolutionary potential of species by maintaining natural levels of diversity which is essential for species and populations to respond to long- and short-term environmental changes in order to overcome stochastic factors failing which would result in extinction.

3.1.1 Conservation strategies for medicinal plants

The best means of conservation is to ensure that the populations of species of medicinal plants continue to grow and evolve in the wild - in their natural habitats. Such *in situ* conservation is achieved by setting aside areas as nature reserves and national parks (collectively termed "Protected Areas") and by ensuring that as many wild species as

possible can continue to survive in managed habitats, such as farms and plantation forests. The various strategies (*In-situ* conservation and *Ex-situ* conservation) for conserving medicinal plants are as discussed:

***In-situ* Conservation:** *In situ* or on-site conservation involves maintaining genetic resources in their natural habitats i.e., within the ecosystem to which it is adapted, whether as wild or crop cultivar in farmer's field as components of the traditional agricultural systems. The key operational steps for establishing *in situ* gene-banks for conservation of prioritized medicinal plants include: threat assessment, establishment of a network of medicinal plant forest reserves, involving local stakeholders, botanical, ecological, trade and ethno-medical surveys, assessing intraspecific variability of prioritized species, designing species recovery programs, establishment of a medicinal plant seed center etc. Finally, no *in situ* conservation project can succeed without the complete cooperation and involvement of local people. The *in-situ* conservation can be achieved through natural reserves and wild nurseries.

a. **Natural reserves:** The degradation and destruction of habitats is a major cause of the loss of medicinal plant resources. Natural reserves are protected areas of important wild resources created to preserve and restore biodiversity. Around the world, more than 12,700 protected areas have been established, accounting for 13.2 million km^2, or 8.81 % of the Earth's land surface. Conserving medicinal plants by protecting key natural habitats requires assessing the contributions and ecosystem functions of individual habitats.

b. ***Wild nurseries***
It is impossible to designate every natural wild plant habitat as a protected area, owing to cost considerations and competing land uses. A wild nursery is established for species-oriented cultivating and domesticating of endangered medicinal plants in a protected area, natural habitat, or a place that is only a short distance from where the plants naturally grow. Although the populations of many wild species are under heavy pressure because of overexploitation, habitat degradation and invasive species, wild nurseries can provide an effective approach for in situ conservation of medicinal plants that are endemic, endangered, and in-demand.

***Ex-situ* Conservation:** This involves conservation of biodiversity outside the native or natural habitat where the genetic variation is maintained away from its original location. The *ex-situ* genetic conservation fulfills the requirement of present or future economic, social and environmental needs. Conservation of medicinal plants include a combination of methods, depending on factors such as geographic sites, biological characteristics of plants, available infrastructure, and network having an access to different geographical areas, human resources and number of accessions in a given collection. The *Ex-situ* conservation can be achieved through the following means:

a. ***Botanic gardens:*** Botanic gardens play an important role in *ex-situ* conservation, and can maintain the ecosystems to enhance the survival of rare and endangered plant species. Although living collections generally consist of only a few individuals of each species and so are of limited use in terms of genetic conservation, botanic

gardens have multiple unique features. They involve a wide variety of plant species grown together under common conditions, and often contain taxonomically and ecologically diverse flora. Botanic gardens can play a further role in medicinal plant conservation through the development of propagation and cultivation protocols, as well as undertaking programs of domestication and variety breeding.

b. ***In vitro* regeneration:** *In vitro* regeneration include plant/explant growth, maintenance under disease free condition, retention of regenerative potential, genetic stability, and ensuring that there is no damage to the live material. This is otherwise known as tissue culture techniques. *In vitro* multiplication protocols for fast propagation of a number of medicinal, aromatic and recalcitrant taxa that are difficult to propagate through conventional means would be very useful.

c. ***Cryo-banks for conservation:*** Cryopreservation of plant cells and meristems is an important tool for long term storage of germplasm or experimental material without genetic alteration using a minimum space and maintenance. The development of methods to store apical meristems in liquid nitrogen successfully is needed to aid in the conservation of genetic resources. For long term preservation, cryogenic storage at ultra-low temperatures under liquid nitrogen (50 to -196°C) is the method of choice. Relatively new to plants, cryopreservation has followed advances made in the mammalian systems achieved either through slow cooling or vitrification. Encapsulation/dehydration is another new technique that offers practical advantages. It is based on the technology originally developed for production of synthetic seeds, i.e., somatic embryos encapsulated in a hydrosoluble gel. Several types of *in-vitro* raised materials such as meristems/shoot tips, cell suspensions, protoplasts, somatic embryos and pollen embryos of medicinal and aromatic species have been studied from the cryopreservation perspective.

d. ***Low temperature germplasm storage:*** Preservation by under-cooling has recently been applied to plant tissue cultures. The objective of this approach is to maintain tissues at low temperatures (-10 to -20 °C) but in the absence of ice crystallization. The plant tissues are immersed in immiscible oil and the emulsion thus formed can be under cooled to relatively low temperatures thereby circumventing ice formation, one of the most injurious consequences of low temperature storage. Recently, vitrification, simplified freezing, and encapsulation-dehydration methods have been used for storage of valuable germplasm. These new procedures may replace freeze-induced cell dehydration by removal of all or of a major part of freezable water from cells at room temperature or at 0° C.

e. ***Seed storage modules:*** Usually seeds, being natural perennating structures of plants, represent a condition of suspended animation of embryos, and are best suited for storage. By suitably altering their moisture content (5-8%), they can be maintained for relatively long periods at low temperatures (-18 °C or lower). However, in several species, rhizome/bulb or some other vegetative part may be the site of storage of active ingredients, and often, such species do not set seed. If seeds set, they may be sterile or recalcitrant i.e., intolerant of reduction in moisture or temperature, or, otherwise unsuitable for storage.

4.0 Summary

The threat of extinction being faced by various plants of medicinal values can be addressed through various technologies that *in vivo* and *ex-vivo* conservation and plant tissue culture.

5.0 Self-Assessment Questions

1. List any 2 In-situ and Ex-situ Conservation strategies
2. Define the term *conservation of medicinal plants*
3. list the techniques involved in plant tissue culture
4. The following are conservation strategies except

A. *In-situ* Conservation
B. *Ex-situ* Conservation
C. *In vivo* Conservation
D. *In vitro* Conservation

6.0 Tutor Marked Assessment

1. Write short notes on the following:

a. *In-situ* Conservation
b. *Ex-situ* Conservation

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Module Seven

ATMOSPHERIC ENVIRONMENT, AIR POLLUTION AND PUBLIC HEALTH

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INTRODUCTION

The atmosphere plays a vital role in maintaining the heat balance on the earth by absorbing the IR radiation received from the sun and re-emitted by the earth. In fact, it is this phenomenon, called "the greenhouse effect", which keeps the earth warm enough to sustain life on the earth. Yet, the air is actually a combination of gaseous elements that have a remarkable uniformity in terms of their contribution to the totality of life. When the concentrations of these trace gases accumulate in the atmosphere over a period of time, the air become polluted. This polluted air become injurious to human health through breathing. One of those human activities that increase pollutants level in the atmosphere is bush burning. Biomass-burning is widespread in sub-Saharan Africa; affecting a significant proportion of the forest, grass, and agricultural lands annually. Fires release heat energy, which is propagated by conduction, convection, and radiation.

Learning Outcomes

By the end of this module, you should be able to:

i. list the atmospheric segments
ii. explain the importance of various atmospheric compositions;
iii. define pollutant
iv. recall a scheme for the Formation of Photochemical Smog
v. classify pollutions into various forms;
vi. access the impact of air pollution;
vii. evaluate the impact of biomass burning;
viii. access the health implications of indoor air and outdoor pollution and enumerate possible solutions; and
ix. enumerate possible health effects of Volatile Organic Compounds (VOCs)

Main Body

Introduction

The Module introduces you to various atmospheric segments, their compositions and teaches how you are to access the impact of air pollution on the well-being of the public. The module is discussed under 4 study units.

Unit 1: Environmental Segments

Subunit 1: Layers of Atmosphere

Unit 2: Pollution

Unit 3: Air quality and public health

Subunit 1: Biomass burning

2: Indoor

Unit 4: Volatile Organic Compounds

UNIT 1: ENVIRONMENTAL SEGMENTS

Contents

1.0 Introduction

This study unit introduces you to the definition of environment. The unit will focus particularly on the man's environment called Environmental segments.

2.0 Learning Outcomes

By the end of this unit, you should be able to:

i. define Environment;
ii. discuss at least three of the Environmental Segments
iii. in a tabular form, juxtapose the five regions of the atmosphere

3.0 Main Content

3.1 What is Environment?

Generally, Environment is everything that is around us. It can be living or non-living things. It includes physical, chemical and other natural forces. Living things constantly interact with their environment and adapt themselves to its conditions. **Environment** plays an **important** role in the healthy living of human beings. it matters because it is the only home that humans have, and it provides air, food, and other needs.

3.2. Environmental segments

The total global environment consists of four major realms. These are; lithosphere, hydrosphere, biosphere and atmosphere

Lithosphere:

The lithosphere consists of upper mantle and the crust. The crust is the earth's outer skin that is accessible to human. The crust consists of rocks and soil of which the latter is the important part of lithosphere. The fig.1 shows the layers of the earth.

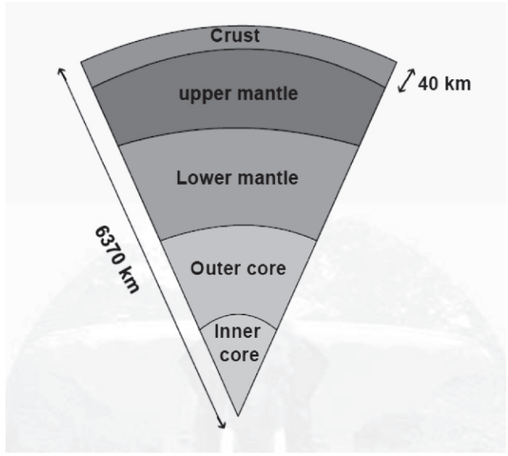


Figure 1: The layers of the earth

Hydrosphere:

The hydrosphere is a collective term given to all different forms of water. It includes all types of water resources such as oceans, seas, rivers, lakes, streams, reservoirs, glaciers and ground waters. The distribution of earth's water supply is that only 1 % of the toatal water is available as fresh water in the form of rivers, lakes, streams, and ground water for human consumption and other uses.

The extent of use of available fresh water for various purposes is shown in fig. 2. The major setback for global water supply is its non- uniform distribution.

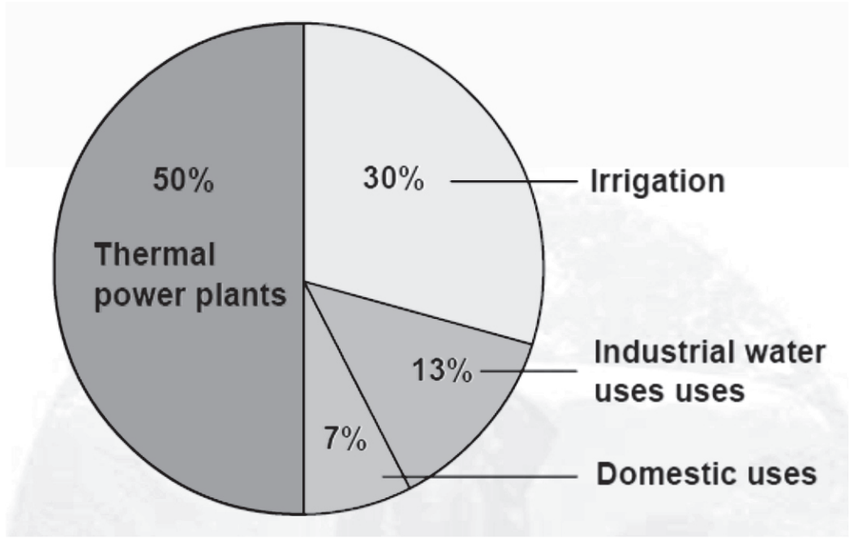


Figure 2: major use of the fresh water

Biosphere:

The biosphere refers to the realm of living organisms and their interactions with the environment. It is very large and complex and is divided into smaller units called ecosystems.

Atmosphere:

The *atmosphere* is comprised of layers based on temperature, altitude and pressure. These layers are the troposphere, stratosphere, mesosphere and thermosphere. A further region at about 500 km above the Earth's surface is called the exosphere. The important of this sphere in the survival of life on it is as follows:

- The atmosphere is the protective blanket of gases which is surrounding the earth.
- It protects the earth from the hostile environment of outer space. It absorbs IR radiations emitted by the sun and reemitted from the earth and thus controls the temperature of the earth.
- It allows transmission of significant amounts of radiation only in the regions of 300 – 2500 nm (near UV, Visible, and near IR) and 0.01 – 40 meters (radio waves). i.e it filters tissue damaging UV radiation below 300 nm.

- It acts as a source for CO_2 for plant photosynthesis and O_2 for respiration
- It acts as a source for nitrogen for nitrogen fixing bacteria and ammonia producing plants.
- The atmosphere transports water from ocean to land.

3.3 The Atmosphere

The *atmosphere* is comprised of layers based on temperature, altitude and pressure. These layers are the troposphere, stratosphere, mesosphere and thermosphere. A further region at about 500 km above the Earth's surface is called the exosphere.

From space, the atmosphere otherwise referred to as the earth's atmosphere, looks like a thin blue veil. This fragile, nearly transparent envelope of gas supplies the air that we breathe each day and it has a mass of about 5.15×10^{15} metric tons, held to the planet **by** gravitational attraction [Stern, 1997]. It also regulates the global temperature and filters out dangerous levels of solar radiation. The atmosphere extends up to about 500 km above the surface of the earth. A constant exchange of matter takes place between the atmosphere, biosphere and hydrosphere with relative weights ratio of 300:1:69,100 respectively [Dara, 2004]. The atmospheric temperature, pressure and density vary considerably with altitude.

Air is all around us, odourless, colourless and essential to all life on earth as it acts as a gaseous blanket, protecting the earth from dangerous cosmic radiation from outer space. It helps in sustaining life on earth by screening the dangerous ultraviolet (UV) radiations (< 300 nm) from the sun and transmitting only radiations in the range 300 nm to 2500 nm, comprising of near UV, visible and near infrared (IR) radiations and radio waves (0.01 to 4×10^5 nm) [Smart, 1998].

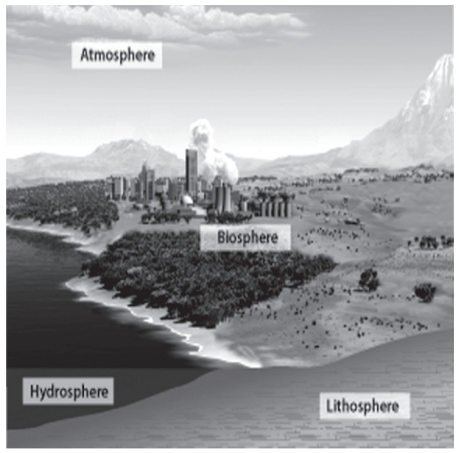


Figure 3: The total global environment consists of four major realms

Figure 4: The earth's atmosphere looks like a thin blue veil from outerspace

The atmosphere also plays a vital role in maintaining the heat balance on the earth by absorbing the IR radiation received from the sun and re-emitted by the earth. In fact, it is this phenomenon, called "**the greenhouse effect**", which keeps the earth warm enough to sustain life on the earth. Yet, the air is actually a combination of gaseous elements that have a remarkable uniformity in terms of their contribution to the totality of life. Thus, oxygen (O_2) supports life on earth; nitrogen (N_2) is an essential macro - nutrient for plants; and carbon (IV) oxide (CO_2) is essential for photosynthetic activity of plants.

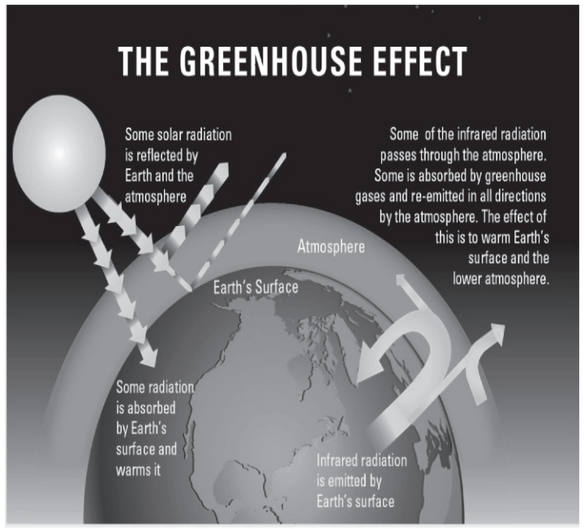


Figure 5: The Greenhouse Effect

Moreover, atmosphere is a carrier of water from the ocean to land, which is so vital for the hydrological cycle. Any major disturbance in the composition of the atmosphere resulting from anthropogenic activities may lead to disastrous consequences or may even endanger the survival of life on earth [Dara, 2004, Abdul Raheem *et al.*, 2009].

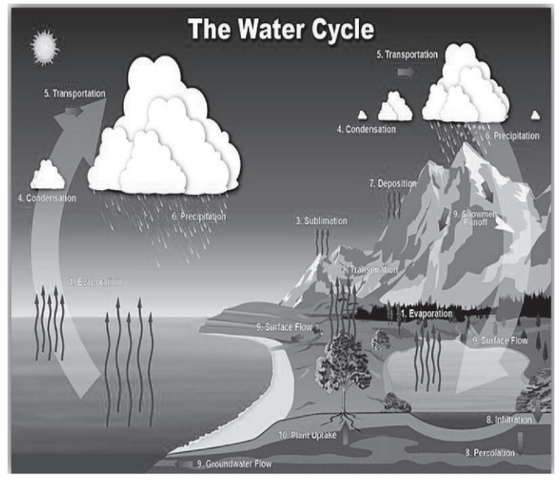


Figure 6: The hydrological cycle, a major role of the atmosphere

The constituent elements are primarily nitrogen and oxygen, with a small amount of argon (Ar). Below 100 km, the three main gaseous elements, which account for about 99.9 % of the total atmosphere, are N_2, O_2 and Ar and they have concentration by volume of 78.09 %, 20.95 %, and 0.93 % of respectively [Stanley, 1975].

The presence of trace amounts of other gases would account for the remaining 0.07 %. These remaining trace gases exist in small quantities and they are measured in terms of a mixing ratio. This ratio is defined as the number of molecules of the trace gas divided by the total number of molecules present in the volumes sampled. For example, ozone (O_3), CO_2, oxides of nitrogen (NO_2 + NO) as NO_x and chlorofluoro carbons (CFCs) are measured in parts per million by volume (ppmv), parts per billion by volume (ppbv) as well as microgram per cubic meter (μgm^{-3}), [Dale, 1976]. If by any way as a result of human activities otherwise known as anthropogenic, the concentrations of these trace compounds are increased, or other forms of pollutants introduced, and bio accumulate over time, then it becomes hazardous to lives exposure.

Layers of Atmosphere

Atmosphere is the mixture of gases surrounding a celestial body with sufficient gravity to maintain it. The studies of Earth's atmosphere are well studied and the science is known as Meteorology. The figure 1 gave illustration of atmospheric layer with their distances to the Earth's surface, while table 1 summarizes the major region of the atmosphere and their characteristics.

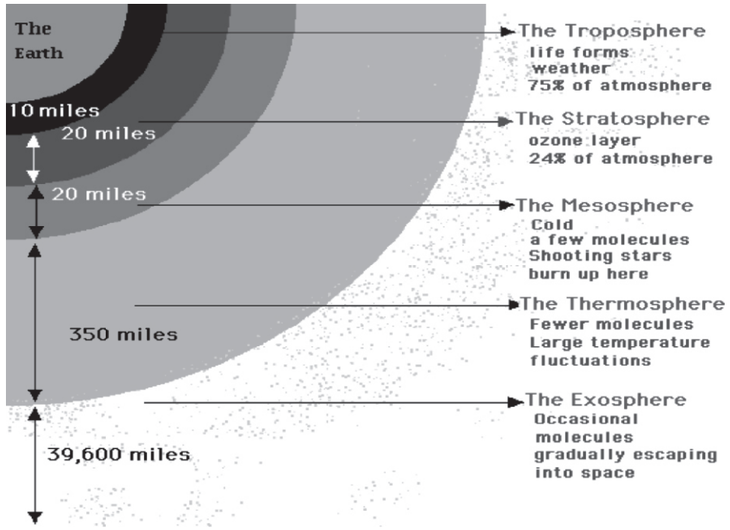


Figure 7: Strata pattern of atmospheric layer (Battu, 2013)

- **Troposphere**

This is the layer of the atmosphere closest to the Earth's surface, extending up to about 10-15 km above the Earth's surface. It contains 75 % of the atmosphere's mass. The troposphere is wider at the equator than at the poles. Temperature and pressure drops as you go higher up the troposphere.

- **Stratosphere**

This layer lies directly above the troposphere and is above 35 km deep. It extends from about 15 km above the earth's surfaces.

- **Mesosphere**

Directly above the stratosphere, extending from 50 to 80 km above the Earth's surface, the mesosphere is a cold layer where the temperature generally decreases with increasing altitude. Here in the mesosphere, the atmosphere is very rarefied nevertheless thick enough to slow down meteors hurtling into the atmosphere, where they burn up, leaving fiery trails in the night sky.

- **Thermosphere**

The thermosphere extends from 80 km above the Earth's surface to outer space. The temperature is hot and may be as high as thousands of degrees as the few molecules that are present in the thermosphere receive extraordinary large amounts of energy from the Sun. However, the thermosphere would actually feel very cold to us because of the probability that these few molecules will hit our skin and transfer enough energy to cause appreciable heat is extremely low.

- **Exosphere**

The final layer is the exosphere, which gradually get thinner as it reaches into the vacuum of space at around 700 km above the earth's surfaces. The atmosphere is so attenuated at the altitude that average air molecules travel without colliding. The density of the atmosphere at an altitude of about 9700 km is comparable to that of interplanetary space.

TABLE 1: MAJOR REGIONS OF THE ATMOSPHERE AND THEIR CHARACTERISTICS

	Temperature range °C	Altitude range (Km)	Significant chemical species	Lapse Rate
Troposphere	15 to -56	0 to 11	N_2, O_2, CO_2, H_2O	+ve
Stratosphere	- 56 to – 2	11 to 50	O_3	-ve
Mesosphere	- 2 to – 92	50 to 85	O_2^+ NO^+	+ve
Thermosphere	- 92 to 1200	85 to 500	O_2^+, O^+, NO^+	-ve

4.0 Summary

The Unit discussed environment and it segments. The importance of the segments and interaction within the segments of the environment were equally explored. The atmosphere and its regions were discussed.

5.0 Self-Assessment Questions

i. define environment
ii. explain the segments of the environment
iii. in a tabular form juxtapose the five regions of the atmosphere

6.0 Tutor Marked Assessment

i. what are the importance of the segments to the man's environment
ii. explain using chart the extent of use of available fresh water for various purposes
iii. why is hydrological cycle a major role of the atmosphere

7.0 Further Reading

https://nptel.ac.in/courses/122106030/Pdfs/1_1.pdf
Abdul Raheem, A.M.O., (2007). Measurement, Modelling and Analysis of ozone and ozone precursors in the ambient environment of Lagos and Ilorin cities, Nigeria, Ph.D. Thesis, University of Ilorin-Nigeria.

UNIT 2: POLLUTION

Contents

1.0 Introduction

Air Pollution

Pollutants

These are substances introduced into the environment in an amount sufficient to cause adverse measurable effects on human beings, animals, vegetation or materials.

2.0 Learning Outcomes

By the end of this unit, you should be able to:

i. define air pollutants;
ii. discuss Environmental pollution
iii. Using a diagram give account of formation of photochemical smog

3.0 Main Content

Pollutants are referred to as primary pollutants, if they exert the harmful effects in the original form in which they enter the atmosphere e.g. CO, NO_x, HC_s, SO_x, particulate matter and so on. On the other hand, secondary pollutants are products of chemical reactions among primary pollutants e.g. ozone, hydrogen peroxide, peroxyacetylnitate (PAN) and peroxybenzoyl nitrate (PBN).

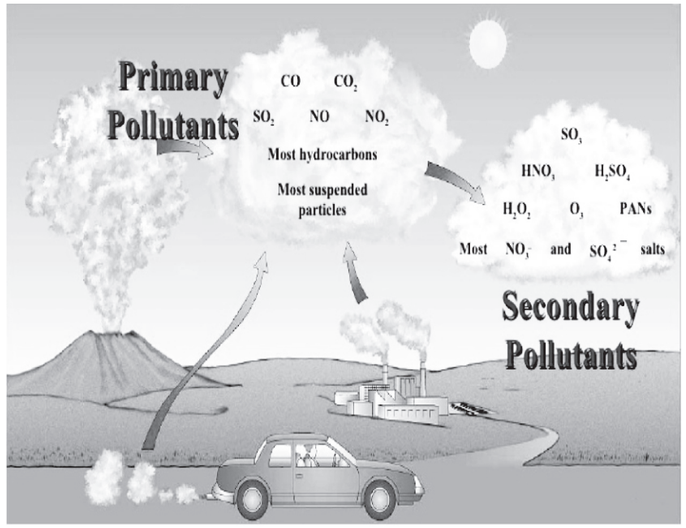


Figure 1: Primary and Secondary Pollutants

Classification of pollutants can also be according to chemical compositions i.e. organic or inorganic pollutants or according to the state of matter i.e. gaseous or particulate pollutants. Air pollution is basically made up of three components and these are source of pollutants, the transporting medium, which is air and target or receptor which could be man, animal, plant and structural facility.

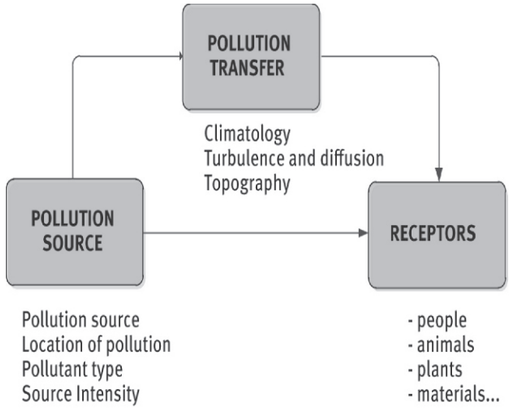


Figure 2: The three components of air pollution

3.1 Atmospheric Photochemical Reaction

The various chemical and photochemical reactions taking place in the atmosphere mostly depend upon the temperature, composition, humidity and the intensity of sun light. Thus, the ultimate fate of chemical species in the atmosphere depends upon these parameters. Photochemical reactions take place in the atmosphere by the absorption of solar radiations in the UV region. Absorption of photons by chemical species gives rise to electronically excited molecules. These reactions are not possible under normal laboratory conditions except at higher temperature and in the presence of chemical catalysts [Hansen *et al*, 1986]. The electronically excited molecules spontaneously undergo any one or combination of the following transformations: Reaction with other molecules on collision; Polymerisation; Internal rearrangement; Dissociation; De - excitation by fluorescence or De - activation to return to the original state [Dara, 2004]. Any of these transformation pathways may serve as an initiating chemical step or a primary process. The three steps involved in an overall photochemical reaction are Absorption of radiation, Primary reactions and Secondary reactions.

Smoggy atmosphere show characteristics variations with time of the day in levels of different pollutants such as NO, NO_2, hydrocarbons, aldehydes and oxidants. A generalised plot showing these variations is shown in Figure 2. This shows that shortly after dawn the level of NO in the atmosphere decreases markedly, a decrease which is accompanied by a peak in the concentration of NO_2. During the mid – day the levels of aldehydes and oxidants become relatively high, however, the concentration of total hydrocarbons in the atmosphere peaks sharply in the morning, then decreases during the remaining daylight hours. The variations in species concentration shown in the above Figure may be explained by a generalised reaction scheme in Figure 3. This is based on the photochemically initiated reactions which occur in an atmosphere containing oxides of nitrogen, reactive hydrocarbons, and oxygen. The various chemical species that can undergo photo - chemical reactions in the atmosphere include NO_2, SO_2, HNO_3, N_2, ketones, H_2O_2, organic peroxides and several other organic compounds and aerosols.

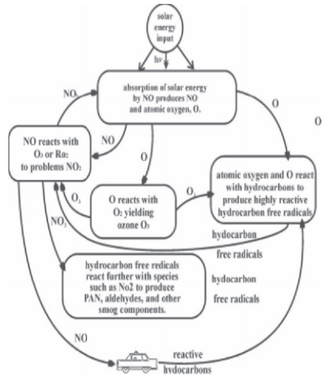


Figure 3: Generalised Scheme for the Formation of Photochemical Smog

3.2 Pollution

Environmental pollution especially air, is one of the main causes of deteriorating living conditions as the breathing of safe air is as important as safe water or food, but the human population in developing countries are compelled to breath polluted air resulting from the combustion of fossil fuels for transport, power generation, cooking and other diffused sources (Albalak*et al.,* 1999). The health consequences of air pollution are considerable.

(a) Air pollution site (b) land polluted site

Figure 4: Digital images of polluted environment

The World Health Organisation (WHO) has estimated that 800,000 people per year die from the effects of air pollution. In particular, air pollution contributes significantly to respiratory diseases (Bruce *et. al*., 2000). Air pollution from combustion sources (figure 4) has been responsible for acid – rain, global warming and malfunctioning of human / animal's haemoglobin [Stanley, 1975], irritation of throat, brochonimonia, asthma etc. (Abdul Raheem *et al*., 2006) Other causes arising from human activities include inappropriate solid waste disposal, gas flaring and oil exploration. Air pollution can also arise from natural causes such as volcanic eruption, whirlwind, earthquake, decay of vegetation, pollen dispersal, as well as forest fire ignition by lightning.

3.0 Summary

The unit discussed the pollutants, process of air contamination, photochemistry, photochemical smog formation within and pollution.

4.0 Self-Assessment Questions

i. Explain definition of pollution;
ii. Classify pollutions into various forms and lay more emphasis on Air pollution; and
iii. Critically access the impact of air pollution.

5.0 Tutor Marked Assessment

i. Explain the process of photochemical smog production
ii. Using organogram explain the 3 components of air pollution

6.0 Further Reading

Dale, F.R., 1976 Strategy of Pollution control, Willars Grant Press, Boston, 8
Dara, S.S, 2004 A Textbook of Environmental Chemistry and Pollution Control. S. Chand & Company Ltd. New Delhi – 110055
Ghauri, B., Lodhi. A .and Mansha. M., 2007 Development of baseline (air quality) data in Pakistan, Environmental Monitoring and Assessment 127 (1 – 3) 237 – 252

UNIT 3: AIR QUALITY AND PUBLIC HEALTH

Contents

1.0 Introduction

Air Quality and Public health

Several studies have been carried out on the quantification of pollutants and analysing their consequences on public health and the environment. It has been estimated that each year between 250 and 300 million tons of air pollutants enter the atmosphere above the United States of America [Onianwa *et al*., 2001; Abdul Raheem *et al*., 2009]. Tropospheric pollution causes degradation of crops, forests, aquatic systems, structural materials, and human health.

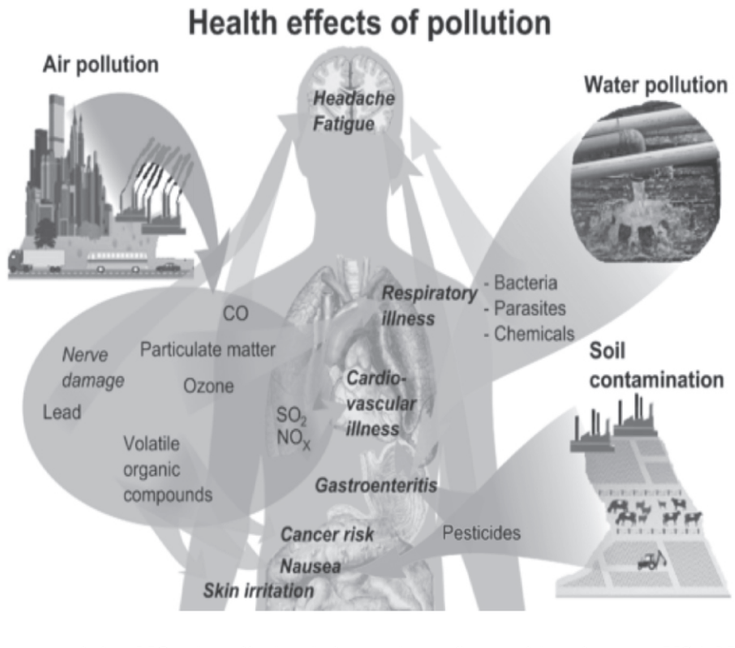
2.0 Learning Outcomes

By the end of this unit, you should be able to:

i. access health effect of pollution ;
ii. write short note on biomass burning
iii. discuss indoor air and its health implication

3.0 Main Content

3.1 Health effects of pollution



It was reported that NO_x air pollution is becoming a far-reaching threat to USA National Parks and Wilderness Areas as these areas are suffering from harmful effects of oxides of nitrogen pollution [Environmental Defense Fact Sheet (EDFS), USA 2003]. It has also been confirmed that NO_x along with other pollutants contributes to ground – level ozone (smog) [Abdul Raheem, 2007; Abdul Raheem *et al.*, 2017] pollution which can cause serious respiratory problems, especially in young children and the elderly, as well as healthy adults that are active outdoors. In addition, ground level ozone is an air pollutant that causes human health problems and damages crops and other vegetation. It is a key ingredient of urban smog. Furthermore, another report confirmed worsening ozone concentration in nearly all the national parks over the last decade in U.S.A [Environmental Defense Fact Sheet (EDFS), USA 2003].

An assessment of new vehicles emission certification standards was carried out in metropolitan area of Mexico City and the results show that light duty gasoline vehicles account for most carbon (II) oxide (CO) and NO_x emissions [Schifter *et al.*, 2006]. The European Environmental Agency also reported very recently that more than 95 % contribution to nitrogen oxides emission to the air comes from fuel combustion processes from road transport, power plants and industrial boilers [EEA, 2006]. There is reported evidence of average chronic damage to the human lung from prolonged ozone exposure

[EEA, 2006]. Sulphur in coal, oil and minerals are the main source of the Sulphur (IV) oxide (SO_2) in the atmosphere. Moreover, peak concentrations above European Union limit still occur, especially close to point sources in the cities.

Asian cities have some of the highest levels of air pollution in the world. In Asia, hundreds of thousands of people in urban areas get sick just by breathing the air that surrounds them. However, the WHO, 2006 estimates that dirty air kills more than half a million people in Asia each year, of which burden falls heaviest on the poor as reported by Ogawa, 2006. The worsening of the situation has been attributed to cumulative effects of rapid population growth, industrialisation and increased use of vehicles. Environmental damage frequently results from several primary and secondary pollutants acting in concert rather than from a single pollutant.

Tropospheric oxidants such as ozone, propyl benzene nitrile (PBN), propyl acetyl nitrile (PAN) as well as methyl and non-methyl organic pollutants illustrate the complexity of atmospheric chemistry and processes. They help to form acidic and toxic compounds thereby contributing to greenhouse warming and hence, damage to human health, animal, plant life and materials [USEPA, 1998; Dara, 2004].

Significant changes in stratospheric ozone, high above the troposphere, can affect tropospheric oxidants level [USEPA, 1998]. If increased Ultraviolet –B (UV-B) radiation penetrates a depleted ozone shield, the photochemical formation of ground level oxidants may be enhanced. Greenhouse warming could amplify this effect: A study carried out in three U.S. cities; Nashville, Philadelphia, and Los Angeles showed that a large depletion of stratospheric ozone, coupled with the greenhouse warming, could increase smog formation by as much as 50 % [Adelman, 1987].

The study also showed that NO_2 concentration might increase more than ten folds. There is however progress towards the reduction of anthropogenic emissions of NO_x, CO, volatile organic compounds in Europe and North American [Jonson *et al,* 2001]. However, the concentration of air pollutants emitted into the atmosphere is on the increase in the Southeast Asia and other parts of the World including Nigeria [Jonson *et al.,* 2001; Abdul Raheem *et al.*, 2009]. It is therefore expected that the emissions from Africa and other parts of the Worlds that are yet to take strict and effective controlling measures on emissions will influence the free tropospheric levels in most of the Northern Hemisphere.

3.2 Biomass burning

This is another way (of polluting the atmosphere) by which man unknowingly contributes to emission of greenhouse gases and consequently impact negatively on health. Biomass burning is the burning of living and dead vegetation. It includes the human-initiated burning of vegetation for land clearing and land-use change as well as natural, lightning-induced fires. Scientists' estimate that humans are responsible for about 90 % of biomass burning with only a small percentage of natural fires contributing to the total amount of vegetation burned [WMO, 1991].

Biomass burning can equally be viewed as emission of combustion products that includes greenhouse gases into the atmosphere and the loss of biomass useful as valuable material resource. The extent of biomass burning generally in Africa and particularly in Nigeria coupled with the complexity of the reactions involved; alongside its health implications constitute an important motivation to view it as a global problem deserving priority attention and careful multisided investigation because air has no boundary i.e. it is transboundary.

Burning vegetation releases large amounts of particulates (solid carbon combustion particles) and gases, including greenhouse gases that helps warm the Earth. Greenhouse gases may lead to an increased warming of the Earth or human-initiated global climate change. Studies suggest that biomass burning has increased on a global scale over the last 100 years, and computer calculations indicate that a hotter Earth resulting from global warming will lead to more frequent and larger fires. Biomass burning particulates impact climate and can also affect human health when they are inhaled, causing respiratory problems [Menzel *et al.*, 1991].

Since fires produce CO_2, a major greenhouse gas, biomass burning emissions significantly influence the Earth's atmosphere and climate. Biomass burning has both short- and long-term impacts on the environment. Vegetation acts as a sink, a natural storage area for carbon dioxide by storing it over time through the process of photosynthesis. As burning occurs, it can release hundreds of years' worth of stored carbon dioxide into the atmosphere in a matter of hours. Burning also will permanently destroy an important sink for carbon dioxide if the vegetation is not replaced. It is hypothesised that enhanced post - burn biogenic emissions of these gases are related to fire-induced changes in soil chemistry and/or microbial ecology. Biomass burning, once believed to be a tropical phenomenon, has been demonstrated by satellite imagery to also be a regular feature of the world's boreal forests. One example of biomass burning is the extensive 1987 fire that destroyed more than 12 million acres of boreal forest in the People's Republic of China and across its border in the Soviet Union [Cahoon *et al*., 1991].

Recent estimates indicate that almost all biomass burning is human-initiated and that it is increasing with time. With the formation of greenhouse and chemically active gases as direct combustion products and a longer-term enhancement of biogenic emissions of gases, biomass burning may be a significant driver for global change [Cahoon *et al*., 1991]..

The historic data indicate that biomass burning has increased with time and that the production of greenhouse gases from biomass burning has increased with time. Furthermore, the bulk of biomass burning is human initiated. As greenhouse gases build up in the atmosphere and the Earth becomes warmer, there may be an enhanced frequency of fires. The enhanced frequency of fires may prove to be an important positive feedback on a warming Earth. However, the bulk of biomass burning worldwide may be significantly reduced. Policy options for mitigating biomass burning have been developed (Andrasko *et al*., 1991). For mitigating burning in the tropical forests, where much of the burning is aimed at land clearing and conversion to agricultural lands, policy options include the marketing of

timber as a resource and improved productivity of existing agricultural lands to reduce the need for conversions of forests to agricultural lands. Improved productivity will result from the application of new agricultural technology (fertilizers, etc.). For mitigating burning in tropical savannas grasslands, animal grazing could be replaced by stall feeding since savannas burning results from the need to replace nutrient-poor tall grass with nutrient-rich short grass. For mitigating burning of agricultural lands and croplands, incorporate crop wastes into the soil, instead of burning, as is the present practice throughout the world. The crop wastes could also be used as fuel for household heating and cooking rather than cutting down and destroying forests for fuel as is presently done.

3.3 Indoor Air Quality

Human exposure to air pollution is thus dominated by the indoor environments. Cooking and heating with solid fuels such as cow dung, wood agricultural residuals, coal is about the largest source of indoor air pollution globally. When used in cooking stoves, these fuels emit substantial amounts of pollutants including respirable particles, carbon-monoxide, nitrogen, sulphur oxides and benzene. Nearly half of the world continues to cook with solid fuels e.g. 50 – 75 % of people in Africa, South America, India and China (Bruce *et al*., 2000).

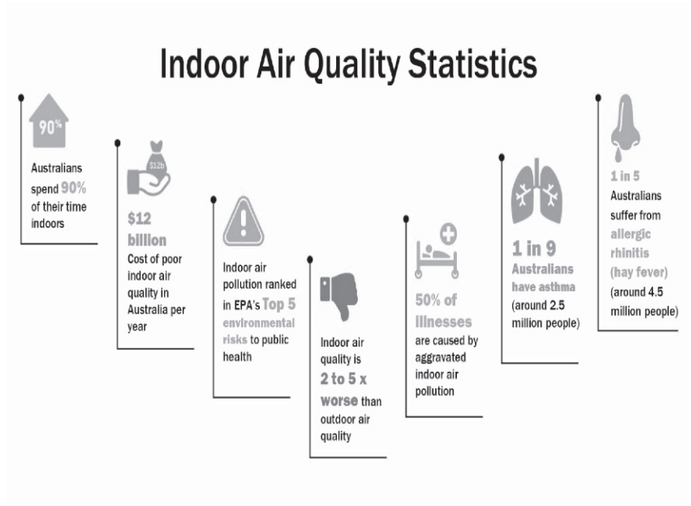
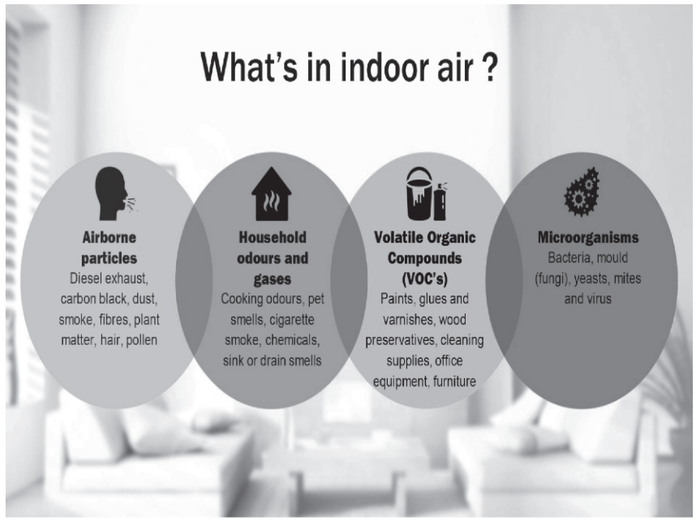


Figure: Some statistics for Indoor Air Quality

Indoor air pollution exposure has been linked with lower respiratory infectious chronic obstructive pulmonary disease, trachea bronchus, lung cancer and asthma.



4.0 Summary

The unit discussed pollutants, pollution, health effects of pollution and the meaning of indoor air and its health implication

5.0 Self-Assessment Questions

i. access health effect of pollution ;
ii. write short note on biomass burning
iii. discuss indoor air and its health implication

6.0 Tutor Marked Assessment

i. access the impact of air pollution;
ii. evaluate the impact of biomass burning;
iii. access the health implications of indoor air and outdoor pollution and enumerate possible solutions; and

7.0 Further Reading

Bruce N., Perez-Padilla R. and Albalak R., Indoor air Pollution in developing countries: A major environmental and public health challenge, Bulletin of the World Health Organization 2000; 78: 1078-92

Atmospheric Part of the Joint U.N. Response to the Kuwait Oilfield Fires. World Meteorological Organization, Geneva, Switzerland, 103 pp

UNIT 4: VOLATILE ORGANIC COMPOUNDS (VOCS)

Contents

1.0 Introduction

Volatile Organic Compounds are essential air pollutant that needed to be addressed critically most especially the indoor VOCs since about 95 % of our activities are been carried out at our homes, offices, workshops, shops, schools and in our different working places. Due to these reasons and many more, the indoor air pollutants are said to be two (2) to five (5) times greater than that of outdoor air pollutants. At times, this may be as high as one thousand (1000) times higher.

2.0 Learning Outcomes

By the end of this unit, you should be able to:

i. discuss VOCs
ii. explain why indoor air make man sick;

3.0 Main Content

3.1 Volatile Organic Compounds

Volatile Organic Compounds (VOCs) is one of the air pollutants present both in indoor and

outdoor settings but the concentration of the indoor setting is much higher than outdoor. Many definitions have been given to VOCs. These definitions vary by locale and they are more a matter of law than a matter of science [Baumbach and Vogt, 2003]. For example, the European Union Directive 2004/42/CE which covers VOC emissions from paints and varnishes defines VOC as any organic compound having initial boiling point less than or equal to 250 ^{o}C measured at a standard atmospheric pressure of 101.3 KPa [EPA-JEA, 1986]. Directive 94/63/EC which regulates VOC emissions from storage and distribution of petrol simply defines "vapours" as any gaseous compound which evaporates from petrol.

Since Photostats and printers emit VOCs, many of the indoor air quality (IAQ) problems that may be faced by the operators of this equipment may be prevented if the staffs and the building occupants understand how their activities affect Indoor Air Quality (IAQ). Therefore, the following precautions and recommendations if properly followed can greatly reduce the effects of these VOCs if they cannot be totally eradicated:

(a) By effective communication, building occupants can be encouraged to improve their work environment through positive contributions.
(b) If a company already has a health and safety committee functioning to promote good working conditions, it is easy to add indoor air quality to their list of concerns.
(c) The responsibilities of building management, staff, and occupants in relation to indoor air quality should be clearly defined.
(d) Occupants should be educated about the permitted uses and maximum occupancy of different areas within buildings and they should make sure that appropriate ventilation is provided for the activities.
(e) Occupants should be educated about the importance of keeping the building management informed about significant changes in the number of people regularly using particular areas of a building.

Generally, Volatile Organic Compounds (VOCs) are a range of high vapour pressure

flammable gases from certain solids and liquids which can easily vaporise at room temperature. This includes a variety of chemicals, some of which may have short or / and long term adverse health effects when inhaled e.g. benzene is a probable human carcinogen and toxic; formaldehyde is both an irritant and a sensitizer.

VOCs from out-gassing of fabrics, building and automobile materials etc. are an important contributor to sick building syndrome (SBS). Photostats and printers off-gas / emit VOCs which are important contributors to photochemical smog.

Daily large quantities of VOCs are emitted into the atmosphere from both anthropogenic and natural sources. VOCs have been found to be a major contributing factor to ozone [Abdul Raheem *et al*., 2008; Ghauri, 2007], a common air pollutant which has been proven to be a public health hazard. The formation of gaseous and particulate secondary products caused by oxidation of VOCs is one of the largest unknowns in the quantitative prediction of earth's climate on a regional and global scale, and on the understanding of local air quality.

1.0 Summary

To be able to control and model their impact, it is essential to understand the sources of VOCs, their distribution in the air [based on Ventilation rate, Indoor and outdoor activities, relative humidity, temperature and building structural characteristic] and the chemical transformations which remove them from the atmosphere. However, If the concentration is higher along with other gaseous pollutants in the troposphere and continues to accumulate over time, the overall concentration can have a negative effect on health, vegetation and structures (Abdul Raheem, 2007; Ghauri, 2007). The findings on indoor concentrations of VOC's reveal the following:

Finally, the problem of global poverty and climate change could be tackled through science, technology and sustainable innovation. Drastic environmental changes such as climate change, pollution, urbanization and land degradation are the major root causes that challenge sustainability, profoundly affecting human security, especially in the poor countries like developing ones. Knowing that air pollutants are continuously released from numerous sources into the atmosphere, which is the primary root of the greenhouse effect that is felt as the global warming, popularly tagged climate change. However, monitoring, mitigating, adapting, and sustainability measures will go a long way in abating the problem.

2.0 Self-Assessment Questions

i. explain why indoor air make man sick;
ii. discuss VOCs

3.0 Tutor Marked Assessment

i. define Volatile Organic Compounds; and
ii. give various examples of Volatile Organic Compounds (VOCs) and their possible health effects.

7.0 Further Reading

Pakistan, Environmental Monitoring and Assessment 127 (1 – 3) 237 – 252

Hansen, J., et al 1986 U.S. EPA Washington D.C. The Greenhouse Effect Project of Global Climate Change; in Effects of Changes in Atmospheric Ozone and Global Climate Vol. 1 Over view: Robert T. Watson, 69-82.

Jonson, J.E., Sundet, J. K. and Tarrason, L., 2001 Model calculations of present and future levels of ozone and ozone precursors with a global and a regional model. Atmospheric Environment 35: 525 - 537

Menzel, W. P., E. C. Cutrim, and E. M. Prins, l991.Geostationary satellite estimation of biomass burning in Amazonia during BASE-A. In J. S Levine (ed.), *Global Biomass Burning: Atmospheric, Climatic, and Biospheric Implications*. MIT Press, Cambridge, Mass., pp. 41~6

Module Eight

FOOD PRODUCTION AND PRESERVATION FOR FOOD SECURITY: THE PLACE OF COOPERATIVES IN NIGERIA

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INTRODUCTION

Food is necessary for health, growth and normal functions of living organisms. It is the material that enables man to grow and reproduce himself (Lapedes, 1977). Essentially food is a mixture of chemicals which could be separated into different components having different functions in the body. One of the greatest world major problems today is how to eliminate hunger and food insecurity. This challenge is greatest in the developing countries where people starve for lack of adequate food and nourishment.

Learning Outcomes

By the end of this module, you should be able to:

i. Analyze food and explain the meaning of food security and insecurity.
ii. Discuss food access, food utilization and the effects of food insecurity on livelihoods.
iii. Highlight five of the constraints militating against adequate supply of high-quality food to consumers.
iv. Enunciate the principles and applications of different methods of food preservation.
v. Clearly explain the solutions to food insecurity.
vi. Itemize the role of cooperatives in mobilising resource-poor, small-scale farmers in agricultural production for a sustainable food security
i. Discuss the role of cooperatives in mobilising resource-poor, small-scale farmers in agricultural Production and food security.

Main Body

Introduction

This module highlights the importance of food security, the constraints militating against getting enough high-quality food to the consumers, and methods of food preservation. Besides, the chapter looks at the role of cooperatives in mobilising resource-poor, small-scale farmers in agricultural production and food security. This module is divided into six units as follows:

Unit 1 **Issues of Food Security**
Unit 2 **Food Preservation**
Unit 3 **Cooperatives in Nigeria**

Unit 1:

Contents

1.0 Introduction

The unit discusses the issues of food security and enunciates the solutions to food security.

2.0 Learning Outcomes

By the end of this unit, you should be able to:

i. Highlight 5 importance of food security
ii. Discuss the constraints militating against getting enough high-quality food to the Consumers

3.0 Main Content

3.1 Issues of Food Security

Food security has been described as an important aspect in any consideration of wealth and economic sustainability of a nation. It is generally defined as a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 2002). Important aspects to be considered in food security issues include the availability of foodstuff, the quality of the diet, the stability of supplies over time and space, and access to food produced (Honfoga & van den Boom, 2003). It is recommended that an individual should consume between 65-86g crude protein per day out of which 35g (40%) must be from animal products.

Although there is variation in the estimate of the food insecure people all over the world, available statistics show that a large proportion of the world population have the problem of food insecurity. It was observed that more than eight hundred million people were food insecure (Wiebe, 2003; FAO, 2005). According to a World Food Program estimate, hunger

affects one out of seven people on the planet. Food insecurity is a particularly serious issue in many low-income countries. For instance, sub-Saharan Africa and South Asia stand out as the two developing-country regions where the prevalence of human malnutrition remains high. The largest absolute numbers of undernourished people are in Asia, while the largest proportion of the population that is undernourished is in Africa, south of the Sahara. In terms of proportionality, this was estimated at 34 percent in Africa and 23 percent in South Asia. (FAO, 1998). Though nutrition insecurity is generally being reduced worldwide, the problem is actually growing worse in Africa. This is due to increasing population growth and poor progress in efforts directed at reducing food insecurity in many countries on the continent (Benson, 2004).

With an estimate of sixty thousand people majority of whom are children dying each day of hunger, food insecurity is considered a common phenomenon in Africa. The majority of the deaths related to food insecurity are reported to occur in sub-Saharan Africa. In virtually all rural sub-Saharan Africa, fluctuation in food security has become a fact of life that majority of the people have to contend with (Milich, 1997). In sub-Saharan Africa, the total number of hungry people increases each year. Given that food deficits are projected to rise, the problem probably will only get worse (Trueblood & Shapouri, 2002; Paarlberg, 2002).

In view of its global dimension, the international community has placed the elimination of famine and hunger on its agenda. The participants at the food summit organised by the Food and Agriculture Organization (FAO) in 1996 pledged to reduce the number of hungry people by half by the year 2015 (World Food Summit WFS, 1996b; FAO, 2005; Meade & Rosen, 2002). Thereafter, the United Nations Rio+20 summit in Brazil in 2012 committed governments to create a set of Sustainable Development Goals (SDGs) that would be integrated into the follow-up to the Millennium Development Goals (MDGs) after their 2015 deadline. Consequently, sustainable food security was adopted as the second goal of the Sustainable Development Goal agenda. This aims at ending hunger and achieving long-term food security including better nutrition through sustainable systems of production, distribution and consumption by the year 2030.

Food insecurity and hunger are forerunners to nutritional, health, human and economic development problems. They connote deprivation of basic necessities of life. As such, food security has been considered as a universal indicator of households? and individuals? personal well-being. The consequences of hunger and malnutrition are adversely affecting the livelihood and well-being of a massive number of people and inhibiting the development of many poor countries (Gebremedhin, 2000). Malnutrition affects one out of every three preschool-age children living in developing countries. This disturbing, yet preventable state of affairs causes untold suffering and presents a major obstacle to the development process. It is associated with more than half of all child deaths worldwide. It is, therefore, the bane of a major waste of resources and loss of productivity which are common occurrences in developing countries. This is because children who are malnourished are less physically and intellectually productive as adults. As such, malnutrition is a violation of the child's human rights (Smith *et. al.,* 2003).

More than 800 million people have too little to eat to meet their daily energy needs. Most of the world's hungry people live in rural areas and depend on the consumption and sale of

natural products for both their income and food. It tends to be concentrated among the landless or among farmers whose plots are too small to provide for their needs. For young children, lack of food can be perilous since it retards their physical and mental development and threatens their very survival. Over 150 million children under five years of age in the developing world are underweight. In sub-Saharan Africa, the number of underweight children increased from 29 million to 37 million between 1990 and 2003 (United Nations, 2005).

Furthermore, food insecurity has been identified as the principal cause of increasing and accelerated migration from rural to urban areas in developing countries. Unless this problem is addressed in an appropriate and timely fashion, the political, economic and social stability of many countries and regions may well be seriously affected, perhaps even compromising world peace (FAO, 1996). This is because hunger can provide a fertile ground for conflict, especially when combined with factors such as poverty and difficulty in coping with disasters (United Nations, 2005).

3. 2 Solutions to Food Insecurity

The concept of food problem is complex and goes beyond the simplistic idea of a country's inability to feed its population. Though the issue of serious food and nutrition problem is associated with less developed countries, the main dimensions of the problems in individual countries have however not been subjected to serious analysis. This has encouraged misleading generalisations about the causes, effects and remedies for the problem (Ojo, 1991). The fight against hunger, therefore, demands an integrated set of actions which simultaneously addresses the causes of food insecurity (Committee on World Food Security CFS, 2005).

The root problem of inadequate access to food is poverty. This is in the sense of the failure of the economic system to generate sufficient income and distribute it broadly enough to meet households' basic needs. The problem can be addressed by either giving food directly to the poor (non-market distribution of aid); increasing their incomes so that they have greater entitlement to food through the market (given existing marketing costs); and/or reducing the costs of food delivered through markets by fostering technical and institutional innovations in farm-level production and the marketing system (Jayne *et.al.,* 1994). The 1996 World Food Summit reaffirmed that a peaceful, stable and enabling political, social and economic environment is the essential foundation which will enable States to give adequate priority to food security and poverty eradication.

Democracy, promotion and protection of all human rights and fundamental freedoms, including the right to development and the full and equal participation of men and women are essential for achieving sustainable food security for all (FAO, 1996). Attaining food security is, therefore, a primary responsibility which rests with individual governments. Access to the components of nutrition security, over and above those required for food security, is also a challenge that must be addressed. Investments in education, sanitation, and access to health care must continue and be increased if the advances required in nutrition security are to be made.

Ultimately, the responsibility of ensuring food security for all lies with national governments who have the duty of establishing the conditions and institutions necessary to enable their citizens to have access to the basic requirements of food and nutrition security. The basic determinants of food and nutrition security in any one African country will never be exactly the same as those of another. This is because of the different historical factors, agro-ecological conditions, economic comparative advantages and institutional structures at play in each of the countries. As such, a single detailed policy and action prescription will not enable national governments in different countries to effectively address malnutrition. It must, however, be recognised that all African countries can attain nutrition security if sufficient commitment exists. Political will must be applied and dedicated efforts made to marshal the human, institutional, and material resources necessary for the task (Benson, 2004).

For there to be an improvement in food and nutrition security situation of a country, national governments must address a number of issues including the following:

i. Enhancing the means to acquire food, whether through cash incomes or access to productive resources. Considering the importance of agriculture as a source of income to rural households, there is a need for improvement in their agricultural production. The effectiveness of on-farm production determines the level of access to food enjoyed by both farmers and the broader population to whom they are linked through the market. Increased food supplies simultaneously increase the income of farming households and reduce the prices people pay for food in the marketplace, both of which enhance nutrition security. Moreover, increases in the production of both food and non-food crops contribute to the broader economy, both in rural areas and in urban manufacturing centres.

ii. Improved education for the chain of food handlers, especially, from the producers to the consumers. This is because the knowledge of why and how food spoilage occurs and the agents responsible for spoilage becomes imperative to enable steps to be taken to prevent or minimise it if we must have fresh and wholesome foods that are safe and nutritious for human consumption at all times (Muhammad and Kayode, 2014). The knowledge of food spoilage and preservation is critical in the food chain to achieve nutritional security and enhanced food productivity for economic growth. Furthermore, training will ensure that people can provide themselves and their dependents with nutritionally balanced and hygienically prepared food.

iii. Provision of access to sufficient quantities of food items. This may require formulation of policy for sustained, broad-based, economic growth. It is estimated that to end hunger in Sub-Saharan Africa by 2050, a 3.5 percent annual average growth rate in per capita Gross Domestic Product (GDP) is necessary for the region.

iv. Direct nutrition interventions to provide food to those suffering from acute hunger and malnutrition and nutrition information and supplements to women of childbearing age and young children are necessary. Such interventions are a vital component of any effort to build the quality of human capital, encourage economic growth, and improve standards of living.

v. Provision of clean water, adequate sanitation and effective health services. This is very important for the individuals to benefit from the food consumed. Poor health situation of the individuals may prevent them from having nutrition security.

vi. Efforts must be made to open national markets to international trade, both within Africa and globally, as national food availability should not depend upon national food production alone. The nutritional security of the population of a country is enhanced by the degree to which it invests in building the institutional and legal frameworks and physical infrastructure needed to facilitate open, reciprocal and free trade.

vii. The issue of gender equity must be addressed, as a close link exists between improved child nutrition and the extent to which women participate in making economic decisions within their households. Greater social equity enhances women's access to resources thereby increasing the diversity and quantity of food they can provide and improve the level and quality of the care they can give to their dependents.

viii. Locally conceived and implemented action has been shown to be the most effective way to improve food and nutrition security. National governments should give broad direction to local efforts and facilitate the success of such efforts through resource allocation, institutional support, and the provision of necessary expertise.

ix. Central governments should ensure that budgetary allocations reflect the central importance that food and nutrition security have for the welfare of all people, as well as the immense economic benefits they provide for relatively little cost. In this regard, donor funding should be viewed as a secondary resource and used to complement the resources allocated by governments.

x. Dedicated advocacy should be used to inform policymakers at all levels of the critical role that improved nutrition plays in development and poverty alleviation. Without this, it is unlikely the malnourished will receive any attention in any planning and resource allocation decisions made in the democratic, decentralised, bottom-up political systems emerging across Africa. The need to improve food and nutrition security must be communicated effectively and understood widely; its significance for the welfare of all members of society must be recognised. Ultimately, advocacy must build the political will needed to ensure that resources are provided to help individuals and households attain food and nutrition security.

4.0 Summary

The unit discuss issues of food security, solution to food insecurity and ten (10) issues to be addressed by National Government for there to be an improvement in food and nutrition security situation of a country.

Self-Assessment Questions (SAQs)

i. Highlight 5 importance of food security

ii. Discuss the constraints militating against getting enough high-quality food to the Consumers

6.0 Tutor Marked Assessment

i. What is food?
ii. List the six constituents of food
iii. List with examples the two classifications of food based on chemical constituents
iv. Explain the following terms: food security, food insecurity
v. what are the importance of food and the effects of food insecurity on livelihoods?

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UNIT 2 FOOD PRESERVATION

Contents

1.0 Introduction

Food spoilage is discuss as a major problem facing farmers in Nigeria because of what it does

to quality and quantity of food, the unit then dwell into different methods of food preservation.

2.0 Learning Outcomes

At the end of this unit, you should be able to:

i. Define food spoilage
ii. List 5 factors that can cause food spoilage
iii. Enunciate the principles and applications of different methods of food preservation.

3.0 Main Contents

3.1 Food Preservation

One major issue that is central to the achievement of sustainable food security in Nigeria is a reduction in food spoilage. This is because of its effects on the quantity and quality of food available to the consumer. Spoilage is the adverse changes in the quality of food due to biological reactions. Similarly, the terms deterioration or autolysis could be described as the adverse changes in the quality of food as a result of physical and chemical reactions that occur within the food system (Muhammad & Kayode, 2014). Food spoilage results when the nutritional value, texture, taste of the food are damaged, the food become harmful to people and unsuitable for consumption. On the basis of spoilage, food may be divided into three categories namely perishable foods, semi-perishable foods and stable foods. The inclusion of any food in any of the three categories is based on the level of moisture content of the food as this factor plays a direct prominent role in food spoilage. Food spoilage may be caused by mechanical damage, microbiological activity (bacteria, yeasts, and moulds), autolysis (oxidation reaction and enzymatic activity), insect and rodent attacks, as well as temperature related factors.

Food preservation is the act of protecting food from deterioration and decay so that it will be available for future consumption. Preservation of food has been a major anxiety of man over the centuries. Contamination with microorganisms and pests causes considerable losses of foods during storage, transportation and marketing (15% for cereals, 20% for fish and dairy products and up to 40% for fruits and vegetables). Particularly, pathogenic bacteria are an important cause of human suffering and one of the most significant public health problems all over the world. The World Health Organization (WHO) reported that the infectious and parasitic diseases represent the most frequent cause of death worldwide (35%).

Any method that will create unfavourable conditions for the factors which are capable of adversely affecting the safety, nutritive value, appearance, texture, flavour, and keeping qualities of raw and processed foods, could be used to preserve foods. Since thousands of food products with different physical, chemical, and biological properties can undergo deterioration from such diverse causes as microbial, natural food enzymes, insects and rodent infestations, heat, cold, light, oxygen and moisture content, food preservation methods differ widely and are optimised for specific products. Numerous processing

techniques have been developed to control food spoilage and raise safety. Traditional methods of preserving foods include dehydration, smoking, salting, controlled fermentation (including pickling), and candying; certain spices have also long been used as antiseptics and preservatives. Among the modern processes for food preservation are refrigeration (including freezing), canning, pasteurisation, irradiation, and the addition of chemical preservatives.

(a) High-Temperature Treatment

The use of heat for the preservation of food has been long in human history and its intensity varies. The heat treatment necessary to destroy the microorganisms or their spores varies with the kind of organism, its state and the medium during heating. The heat resistance of microorganism is usually expressed in terms of their terminal death time which is the time it takes to kill a stated number of organisms including their spores at a chosen temperature at a specified condition. True sterility to ensure total destruction of the most heat-resistant bacteria spores in non-acidic foods may require at least 250^0F (121^0C) of wet heat for at least 15 minutes treatment. The term commercial sterility refers to a less severe condition that still assures the destruction of both pathogenic and non-pathogenic organisms, as well as organisms that, if present, could grow in the food and produce spoilage under normal conditions of handling and storage.
The various methods of high-temperature treatments employed in food processing include:

(i) Blanching

Blanching is a slight heat treatment, using hot water, steam, gas or high-frequency radiation that is usually applied to fruits and vegetables before canning or freezing. Blanching could be done by the use of hot water (water blanching) at a temperature of 99^0C for 2-3 minutes by immersing the fruit or vegetable in hot water or steam blanching in which a conveyor containing vegetables or fruits is allowed to pass through a tunnel which is subjected from above and below to jets of steam.

There is also microwave blanching which involves the use of heat generated in the food by subjecting it to high-frequency radiation. A recent development in the food processing industries is the use of gas blanching. The advantages of blanching are given as follow: inactivation of enzymes, reduce in tissue gas thus reducing the volume of the food product, improvements of colour and texture of products especially vegetables, removal of adhering dirt's and slime forming substances on food product and reduction in cooking time of the final product. However, blanching also has drawbacks as follow: It may lead to loss of water-soluble vitamins B and C and leaching of solutes from the food. It may also lead to mushiness of vegetables and fruits if not properly controlled and prolong treatment of vegetables may cause discoloration (Badejo, 1999).

(ii) Pasteurization

The process is named after the French chemist Louis Pasteur, who devised it in 1865 to inhibit fermentation of wine and milk; it also destroys pathogenic microorganisms and extends the shelf life of a food. Pasteurised products still contain many viable organisms

capable of growing and causing spoilage defects. Therefore, pasteurisation is usually combined with another means of preservation such as refrigeration. Thus the ranges of pasteurisation temperature regimes that are practically employed in the food and dairy industries which give almost equal destruction of microorganisms in food include:

(i) Low-Temperature Long Time (LTLT): Heat treatment between 63 and 65^0C for 30 minutes;
(ii) High-Temperature Short Time (HTST): Heat treatment between 71.7 and 75^0C for 15 to 16 seconds; and
(iii) Ultra High Temperature (UHT): Heat treatment between 121 and 138^0C (or higher) for 2 to 5 seconds.

Heating is done under pressure to produce turbulence and to prevent burning of the milk inside a tubular or on a plate-type heat exchanger. The milk produced is essentially sterile and when packaged under aseptic conditions, may be stored at room temperature for several months. Permanent stability, that is the shelf life of about two years, is obtained with foods that can withstand prolonged heating such as bottled juices. There is a greater loss of flavour from foods that are exposed to a longer time-temperature relationship. Therefore, temporary stability (limited shelf life) is only obtained with some foods where prolonged heating would destroy its quality. These foods such as milk usually require subsequent refrigeration. "High-Temperature Short-Time" (HTST) and "Ultra High Temperature" (UHT) processes have been developed to retain a food's texture and flavour quality parameters (Ihikoronye & Ngoddy, 1985).

(iii) Tyndallization

This is a cycle of heat process aimed at destroying the vegetative forms of microbes at a high temperature between 70 – 100 °C followed by cooling to 37 °C by allowing the resistant spores to germinate and finally reheating at a high temperature to destroy the germinated spores. The cycle of heating, cooling and reheating is repeated until the microbial destruction level is satisfactory (Badejo, 1999).

(iv) Sterilization

Sterilisation is a method of heat treatment that is aimed at removing all microorganisms. Temperature sterilisation could be achieved in two ways, i.e. Low-Temperature Longer time (LTLT) or High-Temperature Shorter Time (HTST). For example, milk and milk products are sterilised at temperatures of 121^0C for 5 minutes or 149^0C for 6 seconds. Under this process, all pathogenic and toxin-forming organisms (including both vegetative cells and spores) are destroyed, as well as other types of organisms, which if present could grow in the food and cause spoilage under normal handling and storage conditions. To prevent recontamination sterilised products must be packaged in aseptic and hermetically sealed containers such as cans and bottles.

Types of commercially sterile processes include canning, bottling, and aseptic processing. Most commercially sterile food products have a shelf life of 2 years or longer. The disadvantage of this process, however, is that high temperatures can diminish product

appearance, texture, and nutrient quality. Examples of such foods that could be preserved by this method include all forms of cooked food, milk, beer and wine.

(b) Low Temperatures Treatment

The slowing of biological and chemical activity with decreasing temperature is the principle behind cooling (refrigeration) and freezing preservation. In addition; when water is converted to ice, free water required for its solvent properties by all living systems is removed. Low-temperature treatment prevents the spoilage of food as well as the proliferation of harmful bacteria. Low-temperature treatment involves freezing and refrigeration.

(i) Freezing

Freezing turns water in food into ice crystals which rupture the microbial cells. Water is unavailable for reactions to occur, and for micro-organisms to grow. Some microbial cells are destroyed during freezing due to denaturation as a result of increased concentration of solute in the frozen food while, others are prevented from multiplying(US History Encyclopedia, 2006). Because not all the diversities of bacteria are killed, however, those that survive reanimate in thawing food and often grow more rapidly than before freezing. In freezing, food temperature is reduced to about (-17°C). However, the freezing compartments of some home refrigerators are not designed to give a temperature of -17°C; the temperature needed for prolonged storage of frozen foods.

After we harvest plants or slaughter animals, enzyme reactions can continue and result in undesirable colour, flavour and texture changes in the food. Freezing slows down but does not destroy, enzymes in fruits and vegetables. That is why it is important to stop enzyme activity before freezing. The two methods that can be used are blanching and adding chemical compounds such as ascorbic acid. Fish meat, peas, vegetables and ice-cream are usually preserved using the freezing method.

(ii) Refrigeration

Refrigeration is the process of lowering the temperature and maintaining it in a given space for the purpose of chilling foods, preserving certain substances, or providing an atmosphere conducive to bodily comfort. Storing perishable foods, furs, pharmaceuticals, or other items under refrigeration is commonly known as cold storage. Chilling slows down microbial activities and chemical changes resulting in spoilage. In chilling, food is kept at 0–4 °C. However, at this temperature range some spoilage microorganisms (psychrophiles) may still be alive and grow slowly, so the food cannot be stored for a long time (US History Encyclopedia, 2006).

(c) Controlled Reduction in Moisture Content

The presence of adequate water (moisture) allows numerous biochemical and microbial activities in food (Badejo, 1999). Water exists in foods in various forms either as free water or bound water. Water activity can, therefore, be lowered by removing water from food or

making water available in the food material.

(i) Drying

Drying food is a combination of continuous mild heat with air circulation that will carry the moisture off. When sufficient water is removed from foods, microorganisms (bacteria, yeasts, and moulds) will not grow, and many enzymatic and non-enzymatic reactions will cease or be markedly slowed. The process of drying foods removes roughly 80 to 90 percent of the water content of fruits and vegetables. Because drying removes moisture, the food becomes smaller and lighter in weight. When the food is ready for use, the water is added back and the food returns to its original shape. Drying of foods could be achieved using any of the following: air, oven and microwave oven.

Dried food items can be kept almost indefinitely, as long as they are not rehydrated. The disadvantages of this preservation method include the time and labour involved in rehydrating the food before eating. Moreover, rehydrated food typically absorbs only about two-thirds of its original water content, making the texture tough and chewy. Examples of food preserved by this process include various dried food products such as fruit, coffee, fish, meat and vegetables.

(ii) Dehydration

This is a preservative method which involves the substantial reduction of moisture under controlled conditions of temperature humidity and air flow. Dehydration involves the transfer of sufficient heat to food to cause moisture evaporation. It is different from conventional drying because dehydration is a controlled drying process. Foods preserved by dehydration contain considerably lower water activity and less total water than concentrated foods. Dehydration could be in form of convection drying in which food to be dried is placed in contact with a stream of heated air and heat is transferred to the product mainly by convection. Dehydration can also be by direct contact drying in which the food product is placed in direct contact with a hot surface; here heat is transferred through conduction. Radiant heat drying is also another form of dehydration process using the microwave (Ihikoronye & Ngoddy, 1985).

Freeze-drying (lyophilization) is also another method of dehydration in which food is frozen first and later sublimation occurs thus effecting drying. Freeze drying ensures retention of shape, size and volatile components of the food. It is however expensive. Examples of food preserved by this process include food products like fruit juices, meat and milk.

(iii) Evaporation

Evaporation is a type of heat processing operation which involves a reduction in moisture content of food materials to obtain a concentrated product with high total solids. The reduction in total moisture content often reduces the water activity (amount of available water in food) of a food material. Concentrated food product with little or no moisture does not encourage the growth of microbes. Evaporation can also be carried out at a lower temperature using a vacuum evaporator (Badejo, 1999; Muhammad & Kayode, 2014).

(d) Smoking

The smoke is obtained by burning oak or a similar wood under low breeze/wind at about 93 to 104 °C. Preservative action is provided by such' bactericidal chemicals in the smoke as formaldehyde (HCHO) and creosote (antiseptic obtained from wood tar), and by the dehydration that occurs in the smokehouse: When foods are smoked they absorb various chemicals from the smoke including formaldehyde, formic acid, ketones, acetaldehydes, aldehydes, waxes, resins, tar and alcohol, among other compounds.

Formaldehyde is considered to be the most important antimicrobial compound in wood smoke. It is known that wood smoke is more effective against vegetative cells than bacterial spores and that the rate of germicidal action of the wood smoke varies with the kind of wood employed. The aldehydes cause many microbes to die and the acids lower the pH of the food. Examples of foods preserved by this method include fish, meat, ham and sausage (Badejo, 1999; Muhammad & Kayode, 2014).

(e) Sugaring and Salting

This is the act of treating food with salt, strong salt solution or strong sugar solution. After adding salt or sugar, the water potential outside the micro-organisms is higher than that inside the micro-organisms. As a result water essential for enzyme action and microbial growth is removed by osmosis; the microbial cannot continue to live. However, a high concentration of salt and sugar may make the foods very salty and sugary respectively. Examples of food preserved by this process include bacon, salted fish, soy sauce, jam, fruits in heavy sugar syrup.

(f) Pickling in Vinegar

Food is kept in vinegar since microorganisms cannot grow well in low pH value solutions. Vinegar (acetic acid) slows the growth of spoilage bacteria, gives flavour and softens bones. Vinegar, however, is only a temporary preservative, because enzymes continue to act, softening and spoiling the product. Some kind of vinegar such as apple cider vinegar will darken most vegetables and fruits. Examples of foods preserved by this method are sauces, pickled onions and cucumbers (Shephard, 2006).

(g) Chemical Preservatives

Historically, many toxic substances have been used as food preservatives. Borates, fluorides and various phenols, that serve as antimicrobials, enzyme inhibitors and antioxidants have all been used. However, in the course of time, it became apparent that their efficiency in killing microorganisms was coupled with considerable toxicity to man. Today, the U.S Food and Drug Administration and comparable agencies in various countries vigorously regulate the chemicals that may be added to foods as well as the conditions of their use. There is much pressure to remove chemicals from the food supply, especially where their effects can be achieved by other means.

(h) Irradiation

This is the act or process of exposing the amount of energy in the form of speed particles or rays for improving food safety, eliminating and reducing organisms that destroy the food products. This is a very mild treatment because a radiation dose of 1 kGy represents the absorption of just enough energy to increase the temperature of the product by 0.36°C. It means that, heating, drying and cooking cause higher nutritional losses. Moreover, heterocyclic ring compounds and carcinogenic aromatic produced during thermal processing of food at high temperatures were not identified in irradiated foods. Ionizing radiation or irradiation is used as a method to destroy enzymes and micro-organisms in food, delay ripening of fruits, and vegetables; inhibit sprouting in bulbs, and tubers; remove insects from grains, cereal products, fresh and dried fruits and vegetables; and destroy bacteria in fresh meats, all with minimal effect on the nutritive value of food (Anon, 1991). Irradiated foods are not radioactive. Radiant energy disappears from the food once it is removed from the source of ionising radiation because the food itself never comes into direct contact with the radiation source. The international bodies including the Food and Agriculture Organization (FAO), the International Atomic Energy Agency (IAEA), WHO and Codex Alimentarius Commission (CAC) investigate projects on food irradiation to verify the safety and quality of different irradiated products. It has shown that irradiation used on alone or in combination with other methods could improve the microbiological safety and extend shelf-life. Furthermore, people are very confused to distinguish irradiated foods from radioactive foods. At no time during the irradiation process does the food come into contact with the radiation source and, it is not possible to induce radioactivity in the food by using gamma rays or electron beams up to 10 MeV. The strength of irradiation source and length of food exposure to the irradiation determine the dose; thus food can be treated at different regimes namely; radurization, radicidation and radappertization to achieve different levels of food treatment success.

(i) Canning

Canning is the process of preserving food by cooking, sealing it in sterile airtight cans or jars, and boiling the containers to kill or weaken any remaining bacteria as a form of sterilisation (Shephard, 2006). Sterilisation of the food can also be achieved by irradiation. The process was invented (1809) by Nicolas Appert, a French confectioner. Various foods have varying degrees of natural protection against spoilage and may require that the final step occurs in a pressure cooker. High-acid fruits like strawberries require no preservatives to can and only a short boiling cycle is required, whereas marginal fruits such as tomatoes require longer boiling time and addition of other acidic elements. Low acid foods, such as vegetables and meats require pressure cooking treatment. Food preserved by canning is at immediate risk of spoilage once the can has been opened. Lack of quality control in the canning process may allow ingress of water or micro-organisms. Most such failures are rapidly detected as decomposition within the can causing gas production and the can could swell or burst. However, there have been examples of poor manufacture due to under processing and poor hygiene practices allowing contamination of canned food by the obligate anaerobe, *Clostridium botulinum* which produces an acute toxin within the food, leading to severe

illness or death (Ihikoronye & Ngoddy, 1985).

(j) Fermentation

Many foods, such as cheeses, wines, and beers are fermented foods that keep for a long time before spoilage. This is because their production uses specific starter microorganisms that combat spoilage from other less benign organisms. These micro-organisms keep pathogens in check by creating an environment toxic to themselves and other micro-organisms by producing acid or alcohol. The starter micro-organisms, salt, hops, cool storage temperatures, low levels of oxygen and/or other methods are commonly used to create the specific controlled conditions that will support the desirable organisms that produce food fit for human consumption (Ihikoronye & Ngoddy, 1985).

(k) Controlled environment

Preservation of controlled environment involves Controlled Atmospheric Storage (CAS) and Modified Atmospheric Storage (MAS). CAS and MAS imply the manipulation which may be addition or removal of gases from storage environment to achieve an atmospheric composition condition different from the normal condition. The normal composition of air is 20% oxygen, 79% Nitrogen and 1% carbon dioxide. In MAS this normal gas composition is altered or modified to achieve a reduction in oxygen content while increasing the level of carbon dioxide and nitrogen. Controlled atmospheric storage is a preservation process whereby the gaseous environment is modified to the desired level and controlled at this level within strict limits throughout the storage period (Africa Conference Brief 1980).

Gaseous storage atmosphere changes in MAS continuously throughout the storage period since the gaseous composition is not controlled. The idea of MAS and CAS is traced back to the fact that the elevation of carbon dioxide and reduction of oxygen retards catabolic reactions in freshly harvested respiring foods and slows the growth of aerobic spoilage microorganisms. Both MAS and CAS are known to retard physiological processes (respiration and ripening), minimise mechanical injury and microbial infections to maintain optimum quality and extend the shelf-life of food products. Therefore either of the 2 methods is employed in the storage and preservation of fruits and vegetables.

Other practices that can delay or prevent food spoilage are as follows:

(i) Use of food additives

Food additives are natural and synthetic compounds added to food. The use of food additives is justified when it serve at least one of the following purposes: (i) maintenance of nutritional quality (ii) enhancement of keeping quality or storage stability with reduction in food losses (iii) making the food attractive and acceptable to the consumer and at the same time not leading to deception and (iv) as essential aids in food processing. The functional characteristics of chemical food additives are: to supply nutrients, serve as chelating and antifoaming agents, enhance colour, flavour and texture of food, aid in pressure dispensing,

ripening and maturation process, and prevention of microbiological spoilage, chemical deterioration, and control of insects and rodents.

(ii) Packaging

Packaging is a means of providing a correct environmental condition for food and, as such, provides identification, information and sales appeal, protects the food from contamination, moisture gain or loss, flavour loss and odour pickup, the adverse effects of oxygen and light, physical damage, and intentional tampering. Ultimately, a food product's quality and storage life are determined largely by its package.

4.0 Summary

In this unit, we identified the define the food spoilage, identify factors that causes food spoilage , then discussed in depth different ways (both primitive and modern) of food preservation.

5.0 Self-Assessment Questions (SAQs)

i. Define food spoilage
ii. List 5 factors that can cause food spoilage
iii. Enunciate the principles and applications of different methods of food preservation

6.0 Tutor Marked Assessment

(i) differentiate between low and elevated heat treatment of food for preservation

7.0 Further Reading

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Module Nine

GLOBAL THREAT OF COUNTERFEIT MEDICINES

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INTRODUCTION

Drug is the single chemical substance that forms the active ingredient of medicine, active pharmaceutical ingredient (API) that produces a pharmacological activity. The term "medicines" is used instead of "drugs" to describe pharmaceutical preparations used in clinical health care practice. There are many definitions of counterfeit drugs. Example, a counterfeit drug is a medicinal product with correct ingredients but not in the amounts as provided, wrong ingredients, without active ingredients, with insufficient quantity of active ingredients, which results in the reduction of the drug's safety, efficacy, quality, strength or purity.

Learning Outcomes

By the end of this module, you should be able to:

(i) give a definition drug;
(ii) understand a global perspective of counterfeit medicines;
(iii) describe the magnitude of the burden of counterfeit medicines;
(iv) list factors that encourage counterfeiting of medicines;
(v) discuss the implications of counterfeit medicines; and
(vi) list and explain anti-counterfeit measures in the Pharmaceutical industries

Main Body

Introduction

This module focuses on the threats of counterfeit drug to man. There are two units in this module:

Unit 1: Drugs and Counterfeit Drugs
Unit 2: Implications of Counterfeit Drugs and Anti-Counterfeit Measures

UNIT 1: DRUGS AND COUNTERFEIT DRUGS

Contents

1.0 Introduction

Drug is a substance used to modify physiological or pathological states for the benefit of the recipient. It is the single chemical substance that forms the active ingredient of medicine, Active Pharmaceutical Ingredient (API) that produces a pharmacological activity. Also, drug is any substance or mixture of substances manufactured, sold or advertised for use by man or animal for the purposes of diagnosis, treatment, mitigation or prevention of any disease or disorder abnormal physical state or symptoms thereof Restoration, correction or modification of organic functions, disinfection, the control of vermin, insects, pests or contraception (Pharmacists Council of Nigeria [PCN], 2009a).

The term "medicines" is used instead of "drugs" to describe pharmaceutical preparations used in clinical health care practice (World Health Organization [WHO], 2002). Also, the non-native English speakers frequently associate the word "drugs" with narcotic or illicit substances (hard drugs).

2.0 Learning Outcomes

At the end of this unit, you should be to:

i. give a definition of drug;
ii. explain a global perspective of counterfeit medicines; and
iii. describe the magnitude of the burden of counterfeit medicines

3.0 Main Content

3.1 Definition of counterfeit medicine

According to World Health Organization (WHO, 2003a), a Counterfeit Medicine (CM) is one which is deliberately and fraudulently mislabeled with respect to identity and/or source (WHO, 2003a). The term counterfeiting can apply to both branded and generic products. CM may include products with the correct ingredients or with the wrong ingredients, without active ingredients, with insufficient active ingredients or fake packaging. CM involves a deliberate or intentional attempt to deceive (WHO, 2003a).

However WHO Member States have slight variations of the definition of counterfeit medicines. For instance,

1. United States (U.S.) Federal Food, Drug & Cosmetics Act defines CM as a drug which, or the containers or labeling of which, without authorization, bears the

trademark, trade name, or other identifying mark, imprint, or any likeness thereof, of a drug manufacturer, processor, packer, or distributor other than the person or persons who in fact manufactured, processed, packed, or distributed such drugs, thereby, falsely purports or is represented to be the product of, or to have been packed or distributed by, such other drug manufacturer, processor, packer, or distributor (WHO, 2003a).

2. Pakistan Manual of Drug Laws defines CM as a drug, the label or outer packing of which is an imitation of, resembles or so resembles as to be calculated to deceive, the label or outer packing of a drug manufacture (WHO, 2003a).
3. Philippines Republic Act No. 82036 defines CM as medicinal products with correct ingredients but not in the amounts as provided, wrong ingredients, without active ingredients, with insufficient quantity of active ingredients, which results in the reduction of the drug's safety, efficacy, quality, strength or purity. The CM is deliberately and fraudulently mislabeled with respect to identity and/or source or with fake packaging, and is can applicable to both branded and generic products (WHO, 2003a).
4. Nigerian Counterfeit and Fake Drugs and Unwholesome Processed Foods (Miscellaneous Provisions) Decree, defined fake drug as "any drug product which is not what it purports to be; or any drug or drug product which is so colored, coated, powdered or polished that the damage is concealed or which is made to appear to be better or of greater therapeutic value than it really is, which is not labeled in the prescribed manner or which label or container or anything accompanying the drug bears any statement, design, or device which makes a false claim for the drug or which is false or misleading; or any drug or drug product whose container is so made, formed or filled as to be misleading; or any drug product whose label does not bear adequate directions for use and such adequate warning against use in those pathological conditions or by children where its use may be dangerous to health or against unsafe dosage or methods or duration of use; or any drug product which is not registered by NAFDAC in accordance with the provisions of the Food, Drugs and Related Products (Registration, etc.) Decree 1993, as amended (WHO, 2003a)."

Moreover, International Pharmaceutical Federation (IPF) in collaboration with Commonwealth Pharmaceutical Association (CPA) defined CM as medicinal products which have been deliberately and fraudulently mislabeled with respect to identity and/or source (International Pharmaceutical Federation [FIP], 2011).

Thus, CMs include products with correct ingredients, wrong ingredients, no Active Pharmaceutical Ingredient (API) or fake labeling, substandard product with correct labeling. Other terminologies such as Substandard Medicines and Adulterated Medicines also come under counterfeiting of medicines.

Substandard Medicines (SMs) are genuine medicines also referred to as out-of- standard (OOS) products (WHO, 2006a), but they do not meet quality specifications set for them (WHO, 2006a, WHO, 2003a). SMs is a term used to describe the quality status of genuine medicines. Legitimate manufacturers adhere to official specifications laid down by official Pharmacopoeias: British Pharmacopoeia (BP), United States Pharmacopoeia (USP), and European Pharmacopoeia (EP) for the production of their products. Thus, SMs fail to meet

the pharmacopoeia specifications used for its formulation with regards composition and ingredients

Adulterated Medicines (AMs) are medicines in which the methods used in, or the facilities or controls used for its manufacture, processing, packing, or holding do not conform to or are not operated or administered in conformity with current Good Manufacturing Practice (cGMP) to assure that such medicines meet the requirements of the Food and Drugs Act as to the safety (United States Code [U.S.C.], 2010). Such medicines do not have the identity, strength, quality and purity characteristics which they purport to be or are represented to possess (Swaminath, 2008). AMs purport to be or are represented as medicines whose names are recognized in an official compendium, but have strength differing from the standard set forth in such compendium. In addition, they have quality or purity that fall below the standard set forth in such compendium. AMs consist in whole or in part any filthy, putrid or decomposed substance, or any medicine that has been prepared, packaged or stored under unsanitary conditions where it may have been contaminated with filth thereby rendering it injurious to health. An AM is also any medicine that is packed in a container which is composed in whole or in part of any injurious or deleterious substance which may render the content injurious to health. Any medicine which bears or contains for the purposes of colouring, any colour other than one which is prescribed, or contains any harmful or toxic substance which may render it injurious to health, or has been mixed with some other substance so as to reduce its quality or strength is also AM (Swaminath, 2008).

Thus, CMs include products with correct ingredients, wrong ingredients, no active pharmaceutical ingredient (API) or fake packaging and labeling, substandard and adulterated products with correct labeling. These can be illustrated "mathematically" as shown below:

- ❖ Fake packing and/or labeling + correct quantity of correct ingredient = counterfeit medicine.
- ❖ Fake packing and/or labeling + incorrect quantity of correct ingredient = counterfeit medicine.
- ❖ Fake packing and/or labeling + no active ingredient = counterfeit medicine.
- ❖ Fake packing and/or labeling + wrong ingredient = counterfeit medicine.
- ❖ Genuine packing and/or labeling + incorrect quantity of correct ingredient (deliberate) = counterfeit medicine.
- ❖ Genuine packing and/or labeling + no active ingredient (deliberate) = counterfeit medicine.
- ❖ Genuine packing and/or labeling + wrong ingredient (deliberate) = counterfeit medicine.
- ❖ Genuine packing and/or labeling + incorrect quantity of correct ingredient (not deliberate) = substandard medicine.
- ❖ Genuine packing and/or labeling + unsanitary processing (Bad Manufacturing Practice) = adulterated medicine.
- ❖ Genuine packing and/or labeling + unsanitary facility for processing (Bad Manufacturing Practice) = adulterated medicine.
- ❖ Unsanitary packing and/or labeling + unsanitary facility and processing (Bad

Manufacturing Practice) = adulterated medicine.

❖ Genuine packing and/or labeling + correct quantity of correct ingredient + sanitary facility and processing (cGMP) = genuine medicine.

3.2 Magnitude of the Burden

Menace of counterfeit medicines is recognized internationally. It exists in developed and developing countries. However, the true extent of the problem is not known due to lack of global studies. Appearance of CMs in International commerce was first mentioned as problem at WHO Conference of Experts on rational Drug Use in Nairobi, Kenya 1985 (WHO, 2003a). It has assumed greater importance due to globalization. Globally, it is one of the fastest growing grey economies after prostitution, narcotics, terrorism and arm trade (Swaminath, 2008). According to WHO estimates, CMs are up to 10% of pharmaceutical trade of which 25% is consumed in developing countries. Also, the US based Centre for Medicines in the Public Interest predicted that, counterfeit drug sales will reach USS 75 billion globally in 2010, which is a 90% increase from 2005 (WHO, 2006b).

Reports of 771 cases of substandard medicines were entered into the WHO database on counterfeits in April 1999, of which, 77% were from developing countries. Analysis of the data showed that 60% of the 325 cases had no an active ingredient in the product (WHO, 2003b). Another study in The Lancet concluded that up to 40% of artesunate products (anti-malarial medicines) contain no active ingredients which result in no therapeutic benefits (WHO, 2003b). Also, GlaxoSmithKline in the United States discovered counterfeiting of medicines used for HIV/AIDS treatment in 2002 in which bottles containing Ziagen® (abacavir sulphate) were mislabeled Combivir® (WHO, 2003b). Since both medicines are part of combination therapies for HIV/AIDS, there is potential life threatening adverse drug reactions and toxicity.

There were 46 confidential reports relating to counterfeit medicines from 20 countries that were received by WHO between January 1990-Oct 2000 of which about 60 % are from developing countries while 40 % from industrialized countries (WHO, 2003b). However, Chakravarty et al (as cited in Gautam et al, 2009) stated that vast majority of CMs are thought to be produced in China, India and Russia, though significant numbers of illegal factories have been reported in Nigeria and Philippines. Fake medicines are estimated to represent 13-30 % of pharmaceutical market in India and about 75 % cases of CMs originate from India being a major exporter of CMs to developing countries including ARVs (Chakravarty et al as cited in Gautam et al, 2009).

In 2006, Peru's counterfeit drug sales have risen from an estimate of US$ 40 million in 2002 to US$ 66 million while Russia's Federal Service for Health Sphere Supervision reported that 10 % of all drugs on the Russian market were counterfeit (WHO, 2006b). According to WHO report of CMs for 2005, 50 % of the pharmacies in Dominican Republic operated illegally while 10% of the medicines that arrived in the country were fake and the commercialization of counterfeit medicines generated economic losses of around $40 million to the pharmaceutical industry of El Salvador. In addition, counterfeit pharmaceutical products account for approximately $130 million annual sales in Kenya while pirated drugs constituted 25 % of Indonesia's $2 billion pharmaceutical market

(WHO, 2006b). The WHO reports of CMs for 2004 shows that approximately 70 % of medicines used by the Angolan population were forgeries; an estimate of US$60 million or 5 % of the total annual market of medicines sold in Colombia were contraband, counterfeit or adulterated; 35 % of pharmaceuticals available in the Lebanese market were counterfeit while illegal products represented about 10 % of the pharmaceutical market in Mexico **(WHO, 2006b)**. WHO reports of CMs for 2003 showed that 30 % of drug store outlets visited by food and drug deregulation officers carry and sell counterfeit drugs. Also, WHO reports of CMs for 2002 revealed that 13 % of the drugs on Cambodia domestic market were counterfeit or substandard; an estimation of about 8 % of over-the-counter drugs sold in China are counterfeit; an estimated illegal drugs growth in India was estimated to be from 10 % to 20 % **of the total market while the countries'** pharmaceutical companies claimed a loss in revenue of between 4 % and 5 % annually.

In Nigeria, the era 1985 to 2000 heralded the regime of counterfeiting of products medicines inclusive (Akinyandenu, 2013; Erhun et al, 2001). Furthermore, an estimate of 70 % of drugs in circulation in Nigeria was either fake or adulterated in 2002 while 48 % of goods and drugs imported into the country in 2004 were substandard or counterfeit **(WHO, 2006b).**

Internet-based sales of pharmaceuticals are a major source of counterfeit medicines (WHO, 2006b). Pre-requisite for legally operated Internet pharmacies include government licensed facilities and dispensing of medication on presentation of a valid patient prescription. However, WHO reports showed that illegal Internet pharmacies are operated internationally, sell products that have an unknown or vague origin and sell medications without prescriptions (WHO, 2006b).

The death casualties due to CMs are enormous. In Nigeria, 109 children died after the use of paracetamol syrup in 1990 (Bonati, 2009) while 14 children died after the administration of chloroquine phosphate injection in 1994 (Aluko, 1994). Also, Nigerian supply of 88,000 Pasteur Merieux and SmithKline Beecham meningitis vaccines to Niger in 1995 resulted in about 2,500 deaths after vaccination (Akinandenu, 2013) while 84 children were reported dead between late 2008 and early 2009 due to diethylene glycol-contaminated My Pikin Baby Teething Mixture (Bate et al, 2009). Also, there were cases of counterfeit artesunate-amodiaquine (Ehianeta et al, 2012). The battle against counterfeit medicines in Nigeria led to the promulgation of the Counterfeit and Fake Drugs and Unwholesome Processed Foods (Miscellaneous Provisions) Act No.25 of 1999 which makes provision for the prohibition of sale and distribution of counterfeit, adulterated, banned, fake, substandard or expired drugs (PCN, 2009b). In addition, the promulgation of National Agency for Food and Drug Administration and Control (NAFDAC) Decree No. 15 of 1993 led to the establishment of NAFDAC with the mandate: to regulate and control quality standards for foods, drugs, cosmetics, Medical devices, chemicals, detergents and packed water imported, manufactured locally and distributed in Nigeria. The Federal task force on Counterfeit and Fake Drugs and Unwholesome Processed Foods (Miscellaneous Provisions) Act operates within NAFDAC

Other CMs casualties include 89 people died in Haiti after using cough syrup containing di-ethylene glycol 1995 (WHO, 2006b) and 30 people died in Cambodia after taking counterfeit antimalarial medicine in 1999 (WHO, 2006b). Furthermore, 38% of 104

antimalarial drugs for sale in pharmacies in Southeast Asia did not contain any active ingredients, causing a number of preventable deaths from the disease according to a study in 2001 (WHO, 2006b). In 2004, a trail of death was caused by fake medicine (WHO, 2006b).

All kinds of medicines have been counterfeited which include antibiotics, hormones, analgesics, steroids, and antihistamines. These drugs form almost 60 % of the products reported. In terms of types of counterfeits and their magnitude, the products reported can be grouped into six categories (WHO, 2003a):

- Products without active ingredients, 32.1 %;
- Products with incorrect quantities of active ingredients, 20.2 %;
- Products with wrong ingredients, 21.4 %,
- Products with correct quantities of active ingredients but with fake packaging, 15.6 %;
- Copies of an original product, 1 %; and
- Products with high levels of impurities and contaminants, 8.5 %.

Specific examples of counterfeiting showing country of origin, the year and the type of counterfeiting are as shown in the table below (WHO, 2012):

SFFC medicine	Country/Year	Report
1. Avastin (for cancer treatment)	United States of America, 2012	Affected 19 medical practices in the USA. The drug lacked active ingredient
2. Viagra and Cialis (for erectile dysfunction)	United Kingdom, 2012	Smuggled into the UK. Contained undeclared active ingredients with possible serious health risks to the consumer
3.Truvada and Viread (for HIV/AIDS)	United Kingdom, 2011	Seized before reaching patients. Diverted authentic product in falsified packaging
4. Zidolam-N (for HIV/AIDS)	Kenya, 2011	Nearly 3 000 patients affected by falsified batch of their antiretroviral therapy
5. Alli (weight-loss medicines)	United States of America, 2010	Smuggled into the USA. Contained undeclared active ingredients with possible serious health risks to the consumer
6. Anti-diabetic traditional medicine (used to lower blood sugar)	China, 2009	Contained six times the normal dose of glibenclamide. Two people died, nine people were hospitalised
7. Metakelfin (antimalarial)	United Republic of Tanzania, 2009	Discovered in 40 pharmacies. The drug lacked sufficient active ingredient

4.0 Summary

In this unit, you have learnt that a counterfeit medicine (CM) is one which is deliberately and fraudulently mislabeled with respect to identity and/or source. Pakistan Manual of Drug Laws defines CM as a drug, the label or outer packing of which is an imitation of, resembles or so resembles as to be calculated to deceive, the label or outer packing of a drug manufacture as well as the magnitude of the effects of counterfeit medicine.

5.0 Self-Assessment

I. Define Drug
II. Give 3 definitions of counterfeit medicine
III. Give brief description of the magnitude of counterfeit medicine

6.0 Tutor Marked

I. Give global description of counterfeit drug
II. Give Specific examples of counterfeit drug, showing country of origin, the year and the type of counterfeiting

7.0 References

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UNIT 2: IMPLICATIONS OF COUNTERFEIT DRUGS AND ANTI-COUNTERFEIT MEASURES

Contents

1.0 Introduction

Counterfeit Medicine is a drug with containers or labeling of which, without authorization, bears the trademark, trade name, or other identifying mark, imprint, or any likeness thereof, of a drug manufacturer, processor, packer, or distributor other than the person or persons who in fact manufactured, processed, packed, or distributed such drugs, thereby, falsely purports or is represented to be the product of, or to have been packed or distributed by, such other drug manufacturer, processor, packer, or distributor. This you focus on the implications of these counterfeit drugs and the measures that can be taken against them

2.0 Learning Outcomes

At the end of this module, you should be to:

i. list factors that encourage counterfeiting of medicines;
ii. discuss the implications of counterfeit medicines; and
iii. list and explain anti-counterfeit measures in the Pharmaceutical industries

3.0 Main Content

3.1 Factors Encouraging Counterfeiting of Medicines

There are different factors encouraging counterfeit medicines in our environment. Some of these factors are**:**

1 Lack of or weak enforcement of existing laws on the quality, safety and efficacy of both imported and locally manufactured medicines encourage counterfeiting. Offenders are not afraid of arrest and prosecution (WHO, 2003a)
2. Weak penal actions encourage medicine counterfeiting since there is no fear of being apprehended and prosecuted. This is especially so when there are more severe penalties for counterfeiting non-medicinal products (WHO, 2003a).
3. Absence of or weak drug regulation encourages counterfeiting of medicines. The unique role of medicines require that they be safe, effective and of good quality in order to produce the desired therapeutic effect. To ensure these properties, it is necessary to create a competent national drug regulatory authority with the necessary human and other resources so that the manufacture, importation, distribution and sale of medicines can be adequately regulated (WHO, 2003a).
4. Corruption and conflict of interest adversely affect enforcement of laws prohibiting counterfeiting of medicines (WHO, 2003a).
5. High remunerative trade also encourages counterfeiting of medicine. Low cost of manufacture of counterfeit medicines coupled with high demand for medicines result in significantly high profits (WHO, 2006b).
6. Lack of cooperation between stakeholders results in counterfeiters escaping

detection, arrest, prosecution, and conviction. Also, failure of pharmaceutical manufacturers, wholesalers, retailers and the public to report to national drug regulatory authorities contribute to the flourishing of the menace (WHO, 2003a).

7. Lack of control by exporting countries and within free trade zones results in flourishing of counterfeit medicines. Many exporting countries do not regulate export pharmaceutical products to the same standard as those for domestic use. Pharmaceutical products are sometimes exported through free trade zones where drug regulation is lax, giving room for repacking and relabeling (WHO 2012).
8. Availability/accessibility of advanced technology encourage counterfeiting. A study in The Lancet showed that counterfeiters' ability to reproduce holograms and other sophisticated printing techniques had dramatically improved between 2001 and 2005, making detection even more difficult (WHO 2006b).
9. Poverty sustains counterfeiting. Paying for medicines constitute major recurrent public health expenditures (second to salaries) and also account for over half of all private health expenditures (Dukes, 1997). Some people seek medicines that are sold more cheaply. These are often available from non-regulated outlets, where the incidence of counterfeit medicines is likely to be higher.
10. Low-availability of testing facilities makes detection of counterfeit medicines difficult. Thus, offenders are emboldened to perpetuate counterfeiting.

3.2 Implications of Counterfeit Medicines

The followings are the implications of counterfeit medicines:

1. Public Health Crisis

Counterfeit medicines pose a serious public health threat. This is because their content could be dangerous due to contamination, inadequate or no active ingredient resulting in treatment failure. Ineffective treatment can lead to a complex series of woes (WHO, 2012) such as:

I. drug resistance
II. obsolescence of cheap effective drugs as in the case of anti-malarial medicines
III. adverse drug reactions
IV. increased morbidity (illness)
V. mortality (death),
VI. decline in confidence in public health care systems and healthcare professionals
VII. Loss of confidence of health care practitioners in the medications.

There are also cases of toxicity associated with counterfeit medicines which also leads to the complex series of woes as above.

The complexity of the health crisis due to counterfeit medicines can be best imagined and appreciated with a consideration of the following counterfeit medicine case:

"After his first in-center dialysis in January 2008, Randy Hubley of Toledo, Ohio suffered severe abdominal pain, diarrhea, and shortness of breath. Two days later, Randy collapsed and did not regain consciousness. Investigations attributed his death to heparin, an

anticoagulant that treats blood clotting during kidney dialysis. According to reports, the heparin used before his treatment was counterfeit—the drug was contaminated with oversulfated chrondroitin sulfate, a compound that is structurally similar to heparin, rendering detection of the false substance extremely difficult. Counterfeit heparin induces severe allergic reactions; in 2008, the FDA documented 81 deaths and about 600 allergic reactions linked to the tainted drug. Its origin was traced back to a production plant in Changzhou, China, which also exports pharmaceuticals to Germany, Canada, France, Italy, and other countries" (Finlay, 2011).

2. Threat to National and International Security

According to Finlay (2011), counterfeiting of medicines poses a threat to national and international security. The profits accrued from this sinister crime are increasingly being co-opted by an array of organized criminal and terrorist entities to fund their despicable operation's globally (Finlay, 2011).

3. Negative Economic Impact

Poor therapeutic outcomes also have economic implications. Huge finances are wasted as result of microbial resistance, increased morbidity, hospital admission and long hospital stay, poor quality life, loss of income/low productivity. The economic impact on part of the consumer can be summarized by the slogan "Health is Wealth". Huge wastage of resources (money, man, minutes, material and information) of pharmaceutical manufacturers, wholesalers and retailers due to product obsolescence (as a result of microbial resistance) and product expiration (due to low/no product turnover) (West, 2009). Nationally, there is loss of revenue since counterfeiters evade legitimate taxation (Finlay 2011).

4. Intellectual Property Rights

Counterfeiting of medicines also violates Intellectual Property (IP) Rights as a result of unlawfully bearing a registered trademark in which case the victims of counterfeiting are the trademark owners (Burci, 2013). The breach of IP may include patency and industrial design.

3.3 Anti-Counterfeit Measures in Pharmaceutical Industry

The common and familiar anti-counterfeit measures currently in use in Nigeria include:

1. Tamper-evident/tamper-resistant packing,
The product packing has an indicator or entry barrier which provides visible or audible evidence to the consumers that the product has been tempered with, if breached or missing. Examples include blister packs, tape seals, shrinkable seals, film wrappers and breakable caps (Bansal et al, 2013).

2. Holograms:
There could be combination of three layered security features (Bansal et al, 2013):

a. Overt features,
b. Covert features such as micro-text, scrambled images UV-sensitive or specialized.
c. This requires trained examiners and appropriate decoding equipment.
d. Serialization of hologram. Authentication is combined with traceability.

3. mPedigree:

This is a type of track and trace system. An offshore data centre tracks the codes which are randomly generated by the pharmaceutical manufacturer. The medicine pack has a distinctive panel that reveals a ten-digit code when scratched. This code is sent to a sent to a central number through a short message service (SMS) and a response to the SMS is received. The response indicates whether the medicine is genuine or counterfeit (Sharma, 2011).

In Nigeria, mPedigree has been incorporated into the national quality assurance standards for pharmaceuticals by the Nigeria Government (Sharma, 2011). The practical steps involved in the use of mPedigree in Nigeria are:

a. Scratch the distinctive panel (card) to reveal the **PIN**
b. Text **PIN** to **38353**.
c. Wait for a response.

Note: Text **PIN** only **ONCE**.

3.4 Authentication of a Pharmaceutical Product using Analytical Methods

Analytical methods such as chromatography (High Performance Liquid Chromatography (HPLC), Gas Chromatography (GC) coupled with optical, electrochemical or mass detectors, Thin-Layer Chromatography (TLC), Colorimetry, optical spectroscopy, and isotopic characterization, Near Infra-Red (NIR) and Raman spectroscopies are used to authenticate pharmaceutical products. Raman spectroscopy is an analytical technique which uses the interaction between light and molecular bonds to characterize individual chemicals such that each compound creates a unique fingerprint.
Currently in Nigeria, TruScan Handheld Raman Spectrometer is used by NAFDAC to detect counterfeit medicines. TruScan identifies the slightest difference in the medicine formulation. The user is alerted with a clear "pass" or "fail" reading within seconds of use.

3.5 Recommendations for Combating Counterfeit Medicines

1. There should be development of appropriate medicines policy options, legislation, and enforcement strategies by each country at a national level. The policies should involve all stakeholders.
2. The governments of each country should demonstrate political will/commitment for evolving and implementing programs for combating counterfeit medicines. Political will and commitment should be demonstrated by:
    a. Enacting new drug laws or updating existing drug laws that prohibit counterfeit medicines.
    b. Establishing institutions for the regulation of medicines and clearly setting out in the drug laws, the power, duties and responsibilities of the institution(s)
    c. Training of personnel, including enforcement officers, for national drug control.
    d. Making available necessary financial and other resources.
    e. Ensuring that the drug laws are enforced.
    f. Continuous investment in technologies and strategies that detect counterfeit medicines.
    g. Fostering international cooperation in the control of pharmaceutical.
    h. Entering into bilateral and multilateral agreements with other governments and with international organizations such as World Health Organization (WHO), Interpol and the World Customs Organization (WCO).
3. Judicial procedures and policies should reflect the seriousness of the problem and the offence. There should speedy disposal of cases involving counterfeit medicines. Also severe penal sanctions on convicted offenders should be imposed. Confiscation/forfeiture and destruction of counterfeit medicines should be ordered by the courts.
4. Combating counterfeiting of medicines is a shared responsibility of all persons. Non-Governmental Organizations (NGOs) and Community Based Organizations (CBOs) should be provided with information and methods for counterfeit medicines detection, in order to report cases to the national drug regulatory agencies.
5. Education and information campaigns about the menace of counterfeit medicines, legitimate sources of genuine medicines and the need of patients to inform their prescriber about treatment failure and ADRs should be directed at the general public.
6. Demonstration of greater cooperation between countries at sub-regional, regional and international levels so that privatization and liberalization of the world economy and extensive opening of borders to trade do not contribute to proliferation of counterfeit medicines
7. Internet pharmacy practice should also be regulated through licensure
8. International convention to control trade in counterfeit medicines should be organized by WHO Member States.

4.0 Summary

CMs cause serious public health crisis and constitute major threat to National and International Security. They create negative economic impact and violate Intellectual Property Rights. It is a must to take positive actions today to combat CMs. We must not forget: No action today, no solution tomorrow!

5.0 Self-Assessment Questions

i. List 4 factors that encourage counterfeiting of medicines
ii. Explain the effects of counterfeit medicines
iii. List and explain 5 anti-counterfeit measures in the Pharmaceutical industries

6.0 Tutor Marked Questions

I. List 5 political will and commitment that should be demonstrated by government against drug counterfeit

II. Discuss the authentication of a pharmaceutical product using analytical Methods

7.0 Further Readings

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Module Ten

FUNDAMENTALS OF POULTRY PRODUCTION

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INTRODUCTION

The word poultry refers to birds of economic value to humans. Domestic fowl, chicken, turkey, duck, goose, pigeon are typical examples of domesticated poultry while the non-domesticated ones include ostrich, quail and pheasant.

Learning Outcomes

By the end of this module, you should be able to:

i. know poultry species;
ii. differentiate between egg and meat types of chicken;
iii. understand different types of poultry management systems;
iv. identify basic equipments required in poultry production
v. understand the production cycle in poultry production
vi. understand the basic nutrients and ingredients required in poultry feeds
vii. understand some common diseases of poultry, their symptoms and prevention

Main Body

Introduction


Turkey


Layers and chicks


Ostrich


Peacock


Mallard


Quail


Cock


Goose


duck

The rearing of domesticated bird for the purpose of meat or egg production is the fundamental business of the science of poultry. The organization involved may be a complex one encompassing hatchery, rearing, processing, storage and sometimes feed formulation. Each of the poultry species one way or the other is of economic value to man however, the chicken is more famous and it is widely reared and managed both on small and large scales. The poultry species can be divided into light and heavy strains for the purpose of egg and meat production, all poultry breeds can be used for these purposes. The broilers and cockerels are usually kept for meat production while the pullets (layers) are reared for egg production.The module will be discussed under 2 units.

Unit 1 Management Systems

Subunit 1 Free range management
Subunit 2 Confined management
Subunit 3 Poultry House Equipment
Subunit 4 Specific equipment

Unit 2 Production Cycle of Birds
Subunit 1 Incubation
Subunit 2 Brooding
Subunit 3 Rearing
Subunit 4 Feeding and Nutrition
Subunit 5 Principles of Poultry Feed Production
Subunit 6 Health and Disease Management
Subunit 7 Vaccination and Disease Prevention

UNIT 1: MANAGEMENT SYSTEMS

Contents

1.0 Introduction

This unit discussed Management system of birds generally and types of such systems that are available. This is explained under two subunits.

2.0 Learning Outcomes

At the end of this unit, you are expected to:

i. describe different types of poultry management systems;
ii. explain the cage system;
iii. identify basic equipment required in poultry production

3.0 Main Content

3.1 Management Systems

Rearing environment of the birds is determined by the climatic condition, size of the flock, available facilities and the purpose of rearing. There are two broad management systems and they include the free range (extensive) and the confined (intensive).

3.1.1 Free range management

Birds kept under this system are given access to move freely around in search of feed during the day and are either or not provided with simple shelter during the night for protection against predators and weather. Birds not provided with shelter normally seek the nearby tree, available fence and uncompleted buildings to roost. This system may lead to ownership conflict, pilfering, predation and other forms of loses. In some cases, the cock may stray away with hen and the hen may lay her eggs and hatch them at unknown or odd places. Attempt to relocate the laying nest of the hen with her eggs sometimes lead to total rejection of the eggs. The extensive system though quite loose, allows the birds' free access to insects and grasses at liberty thus producing biological egg and meat. This system does not require additional cost and it is essentially the system that is common among the Nigerian populace. In commercial extensive system however, coops are strategically located to house the birds at night.

Free range system

Advantages of free range system

I. It is cheap to maintain
II. Birds are more resistant to disease outbreak by the reason of large space
III. Birds have advantage of greens and exposure to sunlight for vitamins A and D respectively.

Disadvantages of free range system

I. Birds are exposed to predators
II. Birds are subjected to variation in environmental condition
III. Growth, performance and mating of birds cannot be monitored
IV. No proper records of birds.

3.1.2 Confined management

The practice of confinement allows for additional housing and labour expenditures and it affords proper feeding, ease of management, disease control and record keeping. The housing and feeding schedule under this system are of two considerations: intensive and semi intensive systems

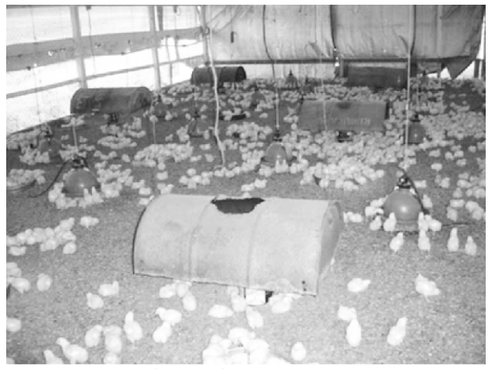
- **Intensive management**

This system can be considered under two divisions: deep litter and cage systems. These two housing systems have a common building structure, but are different by the reason of what is within the house. The general housing pattern for both systems include roof, ridge, wire mesh, dwarf wall foundation and foot dip.

- **Deep litter system**

Litters are absorbent materials that are put on floor in the poultry house on which bird are kept. They include wood shavings, straws, grasses etc. In Nigeria, wood shavings are commonly used by reason of availability and no cost. Birds kept on deep litters can move

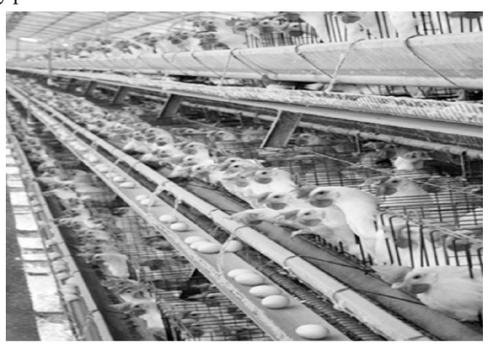
freely around the house. On top of the litters are feeders and drinkers to supply feed and water respectively to the birds. The birds feed and drink as they wonder around the house. The deep litter system can be used for broilers, cockerels, pullet and layers.



Deep litter system

Cage system

Cages are specifically designed for laying hens although they can be used by other birds. In each unit, birds could access feed (feeders) and water (drinkers). The cage units are joined together along the length of the house to form a row. The rows of cage unit can be arranged in either conventional or California/stair. The California form is most common among the Nigerian poultry farmers and in the arrangement, the droppings (feaces) of the birds on top do not fall on the ones under. The feaces are accumulated in a pit under the cage. Cages are sold in units of 48, 96 or 192 with 2-3 birds in a unit depending on their age and size. Improved cages made from wood and designed according to available space and flock sizes are now in use. The advantages of the intensive system include ease of management, clean eggs, and maintained performance. However, the capital outlay is much and there is the problem of flies. Birds in cages may experience "cage layer fatigue"- a condition that is common with highly productive birds.



Battery cage system

Semi intensive system

This is a system that combines the advantages and disadvantages of both extensive and intensive systems of management. In this system, there is fixed house supplied with feed and water for the birds. The fixed house is attached with a fenced pasture for birds to move around.

In general, poultry house should be protective, cheap and well ventilated because chickens are highly susceptible to high temperature and humidity. High temperature results in decreased feed intake and egg production increase in water intake which eventually causes much feacal output. The effect of heat stress is so remarkable that the orientation, location design and facilities for the poultry especially in the tropics most be considered with positive impression. The house should be in east- west direction and should be protected from rodent or vermins. Tall trees near to poultry house should provide shade without obstructing air flow. There should be enough space to accommodate poultry equipment (feeders and drinkers) and to avoid overcrowding of birds.

Free range system

3.2 Poultry House Equipment

Poultry equipment could either be general or specific depending on the stage of growth of the birds.

General equipment

These are those used at any stage of growth of the birds. They include feeders and drinkers. The sizes of this equipment depend on the age, size and number of birds or flock size. The small feeders are usually 0.6 – 1m in length while the large feeders are between 1.5 – 1.8m. The large feeders could be of tube or cylindrical. Most drinkers are in the form of four liter fountain or a long PVC pipe that is prepared for drinking purposes. Automatic feeders and drinkers are also available especially on large commercial farms.

3.2.1 Specific equipment

The specific equipment are those associated with a specific stage in the life of bird. Examples include brooders, laying nest, debeakers, and candler.

Different types of drinkers

Cup drinker

Hanging drinker

Bucket drinker

Fountain drinker

Different types of feeders

Galvanized trough feeders and a plastic tray

4.0 Summary

This unit covers a poultry management system which is the Rearing environment of the birds and they are the free range (extensive) and the confined (intensive). In the free management system, birds are given access to move freely around in search of feed during the day and are either or not provided with simple shelter during the night for protection against predators and weather. While the confined system allows for additional housing and labour expenditures that affords proper feeding, ease of management, disease control and record keeping. The unit also includes some poultry equipment such as the drinker, laying nest and others.

5.0 Self-Assessment Questions

(i) Differentiate between the two types of poultry management systems
(ii) Define poultry cage system
(iii) List three equipment required for poultry production

6.0 Tutor Marked Questions

I. List three advantages and disadvantages of free range system
II. Differentiate between fountain drinker and hanging drinker
III. Explain poultry semi intensive system

7.0 Further Readings

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UNIT 2: PRODUCTION CYCLE OF BIRDS

Contents

1.0 Introduction

The production cycle of birds varies. This unit covers the production life cycle of birds in the prenatal and postnatal stages. Rearing is the management of birds from 8-20/24 weeks of age. This unit also covers essential nutrient and ingredient in poultry feed that must contain necessary fat, vitamins, protein, material, water.

2.0 Learning Outcomes

i. explain Production Cycle of Birds;
ii. describe the feeding and nutrients of birds;
iii. identify the principles of poultry feed production; and
identify common diseases in birds

3.0 Main Content

3.1 Production Cycle of Birds

Stage	Duration	Operations
Prenatal	-21-0 day	incubation
Postnatal	0-8wks	brooding
	9- 20/24wks	rearing
	>20/24wks(POL)	management of adult birds

The production cycle of birds include the following.

3.1.1 Incubation: This stage covers the period of egg fertilization to the time the egg hatches into chick. The stage requires the provision of conducive environment necessary for hatching. The conditions include temperature of 37^0C, relative humidity of 50-60% and ventilation. Incubation can either be natural or artificial. The natural incubation requires the mother hen to sit and hatch the egg. Such mother must however be broody – natural tendency to sit and incubate eggs until they are hatched.

Natural incubation

Artificial incubation is carried out with the use of incubators which can be natural or forced draught type providing an ideal condition to make eggs hatch. The component of incubator includes heating device, temperature regulator, humidifying device, ventilation and egg turning devices. The heat source could be from paraffin, butane gas, coal solar or electricity. Eggs to be incubated should be collected at frequent intervals and should not be stored for more than 7days at temperature between 10-14^{0}C and 75-85% relative humidity. Eggs can be washed in water containing sanitizer and detergent at a temperature above 38^{0}C or at least 12^{0}C warmer than the egg being washed.

Artificial incubator;

3.2 Brooding

This is the management of birds between 0-8weeks of age. It is a demanding operation among the poultry farmers and it requires tender management. During brooding, the poultry house must be clean and its temperature raised to supplement heat to the birds. The temperature within the brooder is about 35^{0}C. Chicks in brooding house can however give an indication of the brooder's temperature by their positioning. If the house is too hot, the birds are positioned far away from the heat source and if is too cold, the birds cramp around the heat source. Chicks are evenly distributed or scattered within the house if the temperature is conducive.

Natural brooding

Artificial brooding

Routine management of birds during brooding

- Supply fresh feed and water daily or you turn the feed remaining from yesterday or sprinkle fresh feed on leftover feed.
- Observe regularly the condition of the birds
- Turn the litters

Specific management during brooding

- Administer appropriate vaccination
- Debeaking
- Wing banding

Trouble shooting during brooding

1. Spread of the in the brooder.
   - If the chicks huddle around or under source of heat then the heat is inadequate. Increase the heat source
   - If the chicks move away from source of heat then, heat is excessive. Reduce the heat source.
   - If the chicks huddle to one side then, there is draught. Curtains can be installed on the sides to reduce draught to ensure adequate brooding temperature.
2. If the chicks appear to be unhealthy then, check for unhealed navel and inform the source of your chicks immediately.

3.3 Rearing

This is the management of birds from 8-20/24 weeks of age. The objective of this operation is

usually to ensure that birds start laying at the right age and size. Rearing is the management for weight and light to get the birds to the point where they are both physically and physiologically matured for egg production. Light is very important for attainment of sexual maturity and initiation of egg laying. The normal daylight in the tropics provides the necessary lightning for the rearing stage.

Management of adult birds

The focal point of this operation is to maximize egg production in terms of egg number and size. The average egg size is 58g and layer is expected to lay about 180-230 in the tropics and 250-300 in the temperate regions. Egg production cycle is divided into three phases. Production increases rapidly in the first two months (phase I), stabilizes during the second phase and then drop in the third phase before going into moulting. Moulting stage is a resting period when birds are not laying but loose their feathers. Moult covers about three months during which the birds repeat the egg production cycle.

3.4 Feeding and Nutrition

Poultry are monogastrics and their nutrient requirements vary with age, species and the purpose for which they are kept. Feed accounting for between 55 and 75% cost of production is associated with laying birds and broilers respectively. Physiologically, chicken have fast growth rate, high internal body temperature of about 41^{o}C. They also have high metabolic rate and fast rate of food passage through gastrointestinal tract. It takes about 3hours for feed taken by chicken to come out as feaces. As a result of these factors, feed for chicken should contain all the essential nutrients needed to meet their body requirement and must be highly digestible, less fibrous and of high biological value.

Essential nutrient and ingredient in poultry feed.

The nutrient require by chicken include the following.

a. **Energy.** The energy content of diet available to the bird for maintenance and production of meat and egg, is referred to as metabolizable energy. It is express in ME per unit weight as calorie per gram (cal/g) or kilocalorie per kilogram (kcal/kg). 1kcal equals 4.2kilojoule. Energy in feed of poultry comes mainly from carbohydrate but also fat and protein. Chicken usually eat to meet their energy requirement. Therefore if the energy of feed is high it will result in low feed intake and *vice versa.* Recommended energy level in poultry diets are about 2800kcal to 2850kcal/kg for layers and about 3000kcal/kg for broilers. When environmental temperature is high, it is advisable to use more concentrated diets to allow birds get enough nutrients in spite of low feed intake.
Sources of energy ingredients include maize, wheat, barley, tubers, fats and oil.

b. **Protein.** Poultry requirement for protein is the requirement for amino acid with reference to essential amino acid. Essential amino acid are those that can not be synthesized by the body of the bird and must be supplied in the diet. They include arginine, histidine, methionine, threonine, valine, isoleucine, lysine, phenylalanine, tryptophan and leucine. The main limiting amino acids are lysine and methionine. A

shortage of these essential amino acids will limit production. Protein requirement of chicken is usually expressed as crude protein which must supply the required amino acids. Protein is usually very expensive, so ration must be balanced with required protein to avoid wastage. The feed of broilers usually contain 23% and 20% crude protein at starter and finisher phases respectively. The sources of protein ingredients include soybean, groundnut cake, palm kernel cake and fish meal.

c. **Fat**. Fat is a high source of energy in poultry diet. It is the richest source of energy containing 2.25 times more energy than carbohydrates. Fat in poultry diets also functions as a source of essential fatty acids such as linoleic acid and also a carrier of fat soluble vitamins such as vitamins A,D,E and K. The problems with use of fat in poultry diet include difficulty of mixing, oxidative rancidity and high cost. The sources of fat include palm oil, vegetable oil, tallow (Animal fat) and full fat ingredients.

d. **Vitamins**. Vitamins are required in poultry diets and are involved in enzyme systems and natural resistance to disease. They are needed in very small quantities but are vital to sustain life. Most vitamins cannot be synthesized; therefore, poultry diets should be fortified with vitamins. Natural vitamins could be obtained from young and green plants, seeds and insects. Poultry in confinement would have to be given diet supplemented vitamins. The level of vitamin supplement should be higher than that recommended. Vitamins may be purchased in a synthetic form and added to diets as premix. Diets without extra vitamins may lead to low productivity.

e. **Minerals**. Calcium and phosphorus are mostly important in poultry diets for bone strength and maintenance. The requirement for these minerals cannot be met by regular feed ingredients and therefore, has to be supplemented. The sources of calcium and phosphorus include bone meal, limestone and oyster shell. Other important macro-minerals include sodium and chlorine added as salt. The micro-minerals such as zinc, manganese, iron etc can be supplied from mineral premix which is available at feed ingredient shops.

f. **Water.** Water is the universal solvent in which nutrients are transported in the body and waste products are excreted. Water is essential to poultry for body temperature regulation. Withdrawal of water from bird would cause low productivity, dehydration and death. It is important that water be made readily available for birds even if feed is of shortage supply. Sources of water include rain water, tap water, well spring etc.

3.5 Principles of Poultry Feed Production

The choice of what is put in commercial poultry feed in terms of nutrients is hardly known by farmers. The farmers just buy and use the feed with expectations of good laying performance and feed to gain ratio. However, these nutrients can be confirmed to ascertain if they are combined in the right proportion. Poultry feeds are produced based on these basic factors

- The nutrient requirement of the bird
- The nutrient composition of the available ingredients and limitation to its use
- The cost of available the ingredients.

Feedstuff or ingredients used in poultry feeds can be classified into five broad groups:

- Cereals (maize, wheat, barley, rye, rice) and cereal-by-products (wheat offal, rice bran, maize bran etc). These ingredients are mainly for energy.
- Tubers (cassava, yam etc) and oils (lard). They are also used for energy.
- Protein rich ingredients from plant source such as soybean, groundnut cake, palm kernel cake etc.
- Animal protein such as meat meal, fish meal, blood meal etc.
- Mineral, vitamin supplements and additives. These include vitamin premix, synthetic amino acid (lysine and methane), enzyme, antitoxin etc.

No single ingredient contains enough nutrients to meet the requirement of the birds. The combination of various ingredients is therefore done carefully to arrive at the nutrients requirements of the birds. Nutrients in chicken diet can be calculated by using Pearson square.

Assuming that there are four different feedstuff to produce a feed of 16.5% crude protein. Using Pearson square, the following steps can be followed to arrive at the requirement.

Step1

The requirement is calculated based on 95% for the ingredient and 5% for additives that may be added.

Therefore the 16.5% crude protein would be

16.5 * 100/95 = 17.37%

Step 2

The available ingredients and their nutrient composition are shown below

Feedstuff	C.P	Energy
Maize	10	3434
Wheat offal	17	1900
Soya bean	42	2750
Groundnut cake	45	2700

**C.P=Crude protein*

Assuming that the maize is cheaper probably because you produced it yourself, then fix the proportion of use depending on the cost

For example, cereal contribution (Maize :2, Wheat offal: 1

Maize 2 →2* C.P(maize)

= 2 * 10 = 20

Wheat offal 1 →1 * C.P (Wheat offal)

= 1 * 17 = 17

20 +17 = 37

Therefore, 37/ 2+1 = 37/3 = 12.33% C.P

Protein Ingredient contribution (Soya bean :3, GNC: 1)

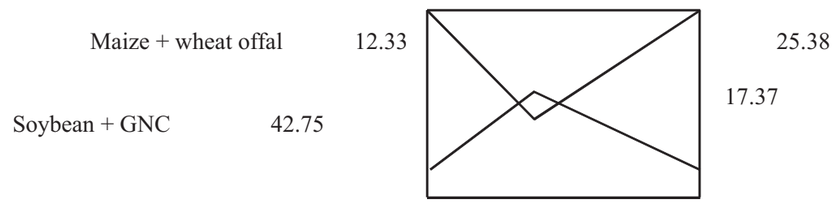
Soybean 3 →3 * C.P (soy bean)

3 * 42 = 126

Groundnut cake(GNC) 1 →1* C.P (GNC)

1 * 45 = 45
126 + 45 = 171
Therefore, 171/1+3 =171/4 = 42.75

Step 3
Place the percentage contribution of cereals on left top of the square and percentage contribution of protein on bottom left. Then place the required crude protein in the centre as shown below



Subtract absolutely the figure in the centre diagonally.

The resulting figure on the right side of the square indicates the proportion of each mixture needed to arrive at the 16.5% crude protein.
From our example, 25.38% is required for cereal, wheat offal contribution while 5.04% is required for soy bean and GNC combination.

Step 4
Express the proportion as a percentage of the total mix of the diet as follows
Cereal combination
(25.38/ 30.42) * 95 = 79.26%
79.26/1+2 = 26.42%
Therefore,
Proportion of wheat offal = 26.42 (1/3)
Proportion of maize = 52.84 (2/3)
Protein combination
(5.04/30.42) * 95 = 15.74%
15.74/1+3 = 3.94
Proportion of GNC = 3.94(1/4)
Proportion of soy bean = 3.94 *3 = 11.81(3/4)

Step 5
Confirming the nutrients in the diet

Feedstuff	% Composition	C.P	Energy
Maize	52.84	5.28	1815
Wheat offal	26.42	4.49	502
Groundnut cake	3.94	1.96	104
Soybean	11.81	4.96	325
Premix and additive	5.0	-	-
Total	100	16.57	2750

The 5% allowance is for additives such as bone meal, essential amino acids and vitamins as may be required by the birds for better performance.

Feeding schedules

Pullet chicks from day 1-8weeks of age can be fed with chick mash containing 18-20 *per cent* crude protein and metabolizable energy of 2900Kcal/kg.Grower mash containing 16% crude protein and 2900Kcal/Kg can be given to chicken that are between 8/9-14weeks while feed of 12-13% crude protein can be given to birds between 14-20weeks of age. This schedule is also applicable to rearing of cockerels. Birds that are older than 20weeks of age which are raised for egg production can be given layers mash containing 16% crude protein, 2850kcal/kg metabolizable energy supplemented with 3% calcium. Broilers from 1-6week of age can be fed with broiler starter containing 23% crude protein 3200kcal/kg of metabolizable energy. It is advisable that broiler should not be kept longer than between 8-10weeks as they tend to deposit more fat beyond this age.

3.6 Health and Disease Management

Disease can occur in poultry at any age and in any breed. Sick birds will always be unproductive and behave strangely. Disease in poultry are important because they can cause outright mortality, economic loss and some are zoonotic (they can be transmitted to man). It is always better to prevent disease than to cure.

Common disease in poultry

1. **Coccidiosis:** This is caused by protozoan parasite and it is spread to chicken particularly young bird through contaminated food, water, or wet litters. The symptom includes blood stain faeces. This disease occurs more with bird in deep litter system. This disease can be prevented by avoiding spillage of water on liter and feed or the use of coccidiostat administer through feed or water.
2. **New castle diseases.** This disease is caused by a virus. It is of global concern, as it is known as the most deadly diseases of poultry. As much as 100% mortality can be recorded especially in young birds. The symptom of this disease include respiratory distress in form of sneezing, coughing and also nervous signs like neck twisting and lack of coordination. Birds can also be passing out greenish feaces. This disease does not have treatment but antibiotics in sterilized water can be used to prevent secondary infection for other chicken and through the use of vaccination. Long acting tetracycline drug can be administered by injection to prevent secondary infection.
3. **Gumboro.** (infectious bursal disease). This is a viral disease that attack the burza of Fibricius which is known to produce antibodies in bird that are 3-8weeks of age. The symptom include listlesness, reduction in feed intake, diarrhea, soiled or dirty feather. There may be nervous sign and mortality. The spread of this disease can be prevented with the use of vaccination.
4. **Chronic respiratory diseases.** This disease occurs in birds that are over 8weeks of age. The symptom include sneezing , respiratory distress railing sound and nasal discharge. This disease can be treated using antibiotics such as tylosine and ampiciline. However, it can be prevented by disinfecting the house and avoiding

chicks from carrier stocks.

5. **Fowl pox.** This is a relatively slow spreading viral disease of poultry that affect all ages. The symptoms include lesions on exposed parts of the body such as wattle and comb. Silver nitrate and gentian violet can be used to treat the lesion. However, vaccination should be used to prevent the disease
6. **Bird flu. (Avian influenza)**. This is a viral disease characterized by respiratory signs, depression, reduced feed and water intake. It affects all classes of poultry. In laying birds, there is a decline in egg production. There is no effective treatment for avian influenza However, good husbandry and proper nutrition accompanied with broad spectrum antibiotics may reduce loses from secondary infection.
7. **Parasite.** Both external and internal parasites can be found on birds. external parasites include lice, mites and tick. They are found on the skin under the feathers. Internal parasites include round and tape worms. Birds affected by parasite are restless. External parasite can be treated using pour on, melathion which is applied inform of dust or spray. Internal worm can be treated with the use of deworming agent. Broad spectrum dewormer to treat both internal and external parasite may also be used.

3.7 Vaccination and Disease Prevention

Vaccination involves the stimulation of immunity through the introduction of disease causing agent into the system. The disease causing agent could either be live, killed or attenuated (weakened) virus called vaccine. The combination of good flock management and vaccination program would prevent disease outbreak.

Flock management and vaccination program

Purchase or manage disease free flock and completely follow the vaccination programme. The following can be practiced to care for birds from day old to maturity.

Day 0: The poultry house and equipment should be cleaned and wood shavings spread to a depth of about 5cm. feeders and drinkers should also be ready.
Day 1: Set brooding temperature and serve feed and water. Inspect chicks and give marek vaccines. Light should be made available for about 22hours in the first days to enable bird to eat well.
Day 3: Give NDV orally and antis- tress in water. Powdered milk and glucose will also prevent disease and make available ready to use energy.
Day 4: Weak, diseased and deformed birds should be removed.
Day 7: Removal of the deformed bird should continue and the light can be reduced to about 18hours.
Day 10: Give gumboro vaccines and anti- stress.
Day 15: Use coccidiostat for about 4days to prevent coccidiosis. Light should also be reduced to 12 hours.
Day 24: Give water soluble lasota vaccine against newcastle disease followed with anti-stress.
Day 28: The litter can be changed and replaced with fresh dry one. About 10-15 bird can be selected randomly for weight infinity.

Day 31: Administered Gumboro vaccine followed with anti-stress.
Day 38: Fowl pox vaccine can be administered followed by anti-stress. At this stage, birds can be moved to a rearing house and all sources of heat short down. The feed of broilers can be changed to finisher (20% crude protein).
Day 43: The feed of the bird is changed from chick mash to growers mash. The feed can be introduced gradually.
Week 7: Vaccinate birds with NDV komorov followed by anti-stress.
Week 8: Birds at this stage should be dewormed followed by anti-stress. Diseased and deformed birds should be cured. This approach is not applicable to broilers as broilers at this age should be at market weight.
Week 10: The litters of the poultry house should be changed and anti-biotics be given to stimulate growth. Bird should also be dewormed followed with anti-stress.
Week 12: Lasota vaccine can be administered followed with anti-stress.
Week 15: The litter should be cleaned and about 10 sample bird be weighed for growth uniformity. Birds should be vaccinated with fowl pox vaccine followed with anti-stress.
Week 16: Birds should be given NDV komorov followed with anti-stress.
Week 20: Birds should be dewormed and then vaccinated at about 3days interval with lasota followed with anti-stress for the next 3 days. About 10 sample birds should be weighed for growth uniformity.
Week 21: Extra calcium source such as oyster shell and limestone should be given. Light should also be made available from 5 am -7 pm. At this stage, birds should be given layers' mash after about 5% egg production. This procedure is not applicable to cockerels.
Week 24: Most of the birds should be laying at this stage depending on breeds of the birds. First egg should be observed at 18weeks and 50% egg production at 22 weeks. It is advisable that cockerels should be sold while the layers continue with egg production for the next 12-18 months. It is also advisable that the birds should be vaccinated with lasota every 4-6 weeks to prevent the incidence of new castle disease followed with anti-stress. The feed and water should also be fortified with vitamins to improve production.

3.7. EVALUATION STRATEGIES

1. What do you understand by the word poultry?
2. List and explain the management systems employed in poultry production and state at least three advantages and disadvantages of each respectively.
3. What are the factors that affect the rearing environment of poultry birds?
4. What is incubation and how many types of incubation do we have?
5. Explain brooding and state the specific routine management carried out during brooding
6. What is the importance of rearing?
7. Chickens feed to meet up their energy requirement true or false?
8. State the recommended energy level for different classes of poultry birds
9. Are vitamins essential in poultry production? State a reason to support your answer
10. What are the problems encountered in using fat in poultry diet?
11. What is the relevance of water in poultry feeding?
12. Differentiate between general and specific equipment in poultry production
13. Differentiate between viral and bacterial diseases of poultry
14. List any two diseases of poultry and their symptoms

1.0 Summary

In this unit, you have learnts:
(i) the Production Cycle of Birds;
(ii) the feeding and nutrients of birds feeds;
(iii) the principles of poultry feed production; and
(iv) common diseases in birds

2.0 Self-Assessment Questions

(i) Describe the production cycle of birds
(ii) List 5 nutrients in bird feeds
(iii) List 3 principles of poultry feed production

3.0 Tutor Marked Questions

I. List 5 evaluation strategies
II. Describe flock management and vaccination program

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Module Eleven

HUMAN NUTRITION- A LIFE COURSE APPROACH

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INTRODUCTION

Nutrition is the science that interprets the relationship of foods to the functioning of the living organism. This will include the intake of food, elimination of wastes and syntheses that are essential for maintenance, growth and reproduction. In other words the interaction of food, the nutrients and other substances therein, their action and balance in relation to health and diseases. Nutrition is so important that it has become a national goal to promote optimal health and disease prevention. Unfortunately, a general dearth of knowledge exists in human nutrition especially as it relates to nutrition of the vulnerable groups (children, pregnant women and the aged). Also, the association between the onset of certain diseases and diet need to be understood. The present Module therefore, provides information on some aspects of human nutrition.

Learning Outcomes

By the end of this module, you should be able to:

(i) define nutrition;
(ii) explain the concept of macro- and micro- nutrients;
(iii) discuss the standards for measuring healthy peoples energy requirements;
(iv) list the various forms of malnutrition;
(v) enumerate the features of kwashiorkor and marasmus;
(vi) explain nutrition in the adolescent, pregnant women and the aged; and
(vii) discuss the causes measurement and management of obesity
.

Main Body

Introduction

This Module on human nutrition and how it relates to vulnerable groups will the discussed under two (units).

Unit 1 **Food Nutrients**
Subunit 1 Nutrition in Children
Unit 2 Nutrition in other vulnerable groups
Subunit 1 Obesity

UNIT 1: FOOD NUTRIENTS

Contents

1.0 Introduction

Food is able to perform its functions because they contain nutrients.
Nutrition contributes to wellness. Therefore, healthful diet is part of disease prevention. Examples of nutrient deficiency diseases include scurvy, goiter, rickets, and anemia. Some forms of chronic diseases are influenced by nutrition; these include heart disease and diabetes.

2.0 Learning Outcomes

By the end of this unit, you should be able to:

(i) define nutrition;
(ii) explain the concept of macro- and micro- nutrients;
(iii) discuss the standards for measuring healthy peoples energy requirements;
(iv) list the 4 various forms of malnutrition;
(v) enumerate the features of kwashiorkor and marasmus;

3.0 Main Content

3.1 Food Nutrients

Food is able to perform its functions because they contain nutrients.
Nutrients are chemicals in foods that our body use for energy and to support the growth, maintenance, and repair of our tissues. There are two broad classes:

i. **Macronutrients** are nutrients that are required in relatively large amounts. These are carbohydrates, lipids and proteins.
ii. **Micronutrients** are nutrients required in smaller amounts like vitamins and minerals.

Nutrients can also be classified as either organic or inorganic. **Organic nutrients** contain an element of carbon that is an essential component of all living organisms e.g Carbohydrates,

lipids, proteins and vitamins. **Inorganic nutrients however** do not contain carbon e.g. Minerals and water.
In man, nutrients are supplied through the food and different food items contain different amount of nutrient. For example rice and bread are rich in carbohydrate while food like beans is rich in protein.
The food sources and functions of food nutrients are summarised in Table 1

Table 1: Nutrients: The food sources and functions.

NUTRIENT	ENERGY/g	FOOD SOURCE	FUNCTION
Carbohydrate	4	Bread, rice, yam, biscuits, sugar	Energy
Fat	9	Oils, butter, cheese,	Energy
Protein	4	Meat, fish, egg, milk	Growth and repair
Minerals	-	Vegetables and fruits	Control of body processes
Vitamins	-	Vegetables and fruits	Control of body processes
Water	-	Drinking water, beverages, fruits and vegetables	Control of body processes

Good nutrition implies the intake of diets containing all the nutrients in proportions necessary for the proper functioning of the body. A diet containing all required nutrients in adequate quantity is said to be a balanced diet. However, because foods are generally rich in different type of nutrients, a combination of foods will often be necessary to attain balance. For example a meal of pounded yam taken with vegetable soup and meat or fish will likely contain all the macro nutrients and many of the micronutrients in adequate quantities. The disruption of the concept of balance coupled with changes in the way food is prepared, processed, as well as lifestyle changes led to imbalance in energy metabolism which have been proposed to be responsible for the appearance of various metabolic syndromes (affliction of affluence).

Nutrient Requirements

The amount of nutrient required varies with age, sex, activities and general well-being. Special requirements of pregnancy and lactation have also been identified. There are standards for measuring healthy people's energy and nutrient requirement.

A set of four values are used to measure the nutrient intake of healthy people
Dietary Reference Intakes (DRI) consists of 4values:
Estimated Average Requirement (EAR): The average daily intake level of a nutrient that will meet the needs of half ofthe ***healthy*** people in a particular category Used to determine the Recommended Dietary Allowance (RDA) of a nutrient
Recommended Dietary Allowances (RDA): The average daily intake level required to meet the needs of 97 – 98% of ***healthy*** people in a particular category
Adequate Intake (AI): Recommended average daily intake level for a nutrient

Based on observations and experimentally determined estimates of nutrient intakes by ***healthy*** people Used when the RDA is not yet established e.g for calcium, vitamin D, vitamin K, fluoride
Tolerable Upper Intake Level (UL): Highest average daily intake level likely to pose no risk of adverse health effects to most people Consumption of a nutrient at levels above the UL, the potential for toxic effects and health risks increases.

The Food Guide Pyramid (Figure 1) was introduced in 1992 and further modified in 2005 to reflects the latest in nutrition science. Dietary Guidelines place stronger emphasis than past guidelines on decreasing calorie intake as well as increasing physical activity.

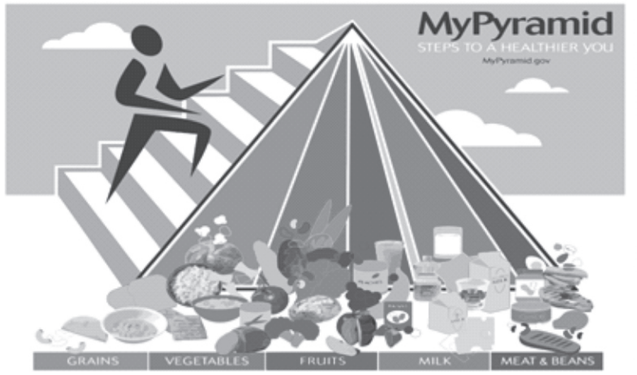


Figure 1: Food Guide Pyramid

The 6 colour bands represent the different food groups, and illustrate that foods from all groups are needed each day. MyPyramid symbolizes a simple, personalized approach to remind consumers to make healthy food choices and to be active every day. **Activity** is represented by the steps and **personalization** by the individual.

3.2 Nutrition in Children

Malnutrition remains one of the most common causes of morbidity and mortality among children throughout the world. Approximately 9% of children below 5 years of age suffer from wasting and are at risk of death or severe impairment of growth and psychological development. In 2008, of the 8.8 million global deaths of children fewer than 5 years of age, 93% occurred in the developing countries of Africa and Asia and over a third of all deaths can be attributed to underlying malnutrition

Childhood Malnutrition

Protein Energy Malnutrition (PEM): This is the most common deficiency disease in the world with about one hundred children affected to a moderate or severe degree.
PEM is caused by a deficient intake of energy and usually protein. Secondary PEM can result as a result of other complications like AIDS, chronic kidney failure, inflammatory bowel

disease and other illnesses that impair the body ability to absorb and / or utilize nutrients, or compensate for nutrient loss.

Causes

Several factors have been identified to be the cause of childhood malnutrition. These include:

- poverty/ insufficient food production
- poor living conditions leading to consumption of contaminated foods and subsequent exposure to infection frequently
- lack of education/ ignorance on nutrient requirement for children
- another pregnancy resulting in improper feeding of children especially breast feeding
- return of mother to work
- poor family planning / multiple births creating competition for the limited food
- paternal dispute often time resulting in child neglect
- war and famine which often times make food unavailable

Summarily, all these factors can be defined by lack of education, poverty and lack of food.

Signs

Some of the features of PEM are

i. muscle wasting
ii. the belly may look prominent
i. the skills develop more slowly.

The more severe ones are **marasmus, kwashiorkor, marasmic kwashiorkor and iron deficiency anaemia**

Features of Marasmus (figure 2a)

i. child often less than one year old
ii. There islow weight for age (usually below 60%)
iii. There is little or no subcutaneous fat therefore skin is loose
iv. The child looks like an old man
v. Noedema and there may be no changes in hair colour
vi. Child usually hungry

Since the body breaks down its own tissue to use as calorie, children suffering from marasmus lose all body fat and muscle strength and acquire a skeletal appearance. They suffer from frequent infection due to weakened immune system.

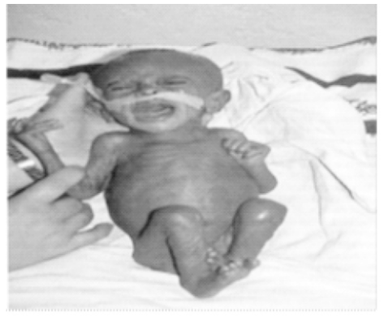
Features of Kwashiorkor (Also called wet PEM; figure 2b)

Child usually is aged 1-3 years and present the following features:

i. Growth retardation
ii. More subcutaneous fat than in marasmic child
iii. There is oedema (mainly in the feet and lower legs)
iv. The child appears moon faced
v. Hair is discoloured
vi. Hair is sparse and is easily pulled out
vii. Presence ofanaemic
viii. Loss of appetite

The body's immune system is weakened, behavioural development is slow and mental retardation may occur. Childrern may grow to normal height but are abnormally thin.

It can also develop in children who are severely burned, suffered trauma or had sepsis (tissue destroying infection).



a. Marasmus

b. Kwashiorkor

PREVENTION: The best way to prevent childhood malnutrition is by breast feeding a child for the first six months and thereafter introduce the child to balanced weaning foods.

Advantages of Breast Feeding

1. Breast milk is complete food
2. It is cheaper
3. It has contraceptive properties
4. It helps in the contraction of the womb, thereby helping the mother to return to shape
5. It is always available in correct composition and temperature
6. No utensils required therefore less chance of germ infestation
7. It has anti-infective properties such as
   - Immunoglobulin A (act against certain bacteria e.g E. Coli and some viruses
   - Lactoferrin which binds iron thereby making it unavailable for certain

microorganisms.
- Lysozymes which breaks down certain harmful bacteria
- White blood cells for fighting infection
- The bifidus factor, a nitrogen containing carbohydrate required for the growth of *Lactobacillus bifidus* a lactic acid producing bacteria.

8. Breast feeding confers protection from allergic diseases e.g. infantile eczema.
9. It gives a woman a sense of womanhood
10. It encourages closeness between mother and child
11. Less environmental pollution.

Excuses for not Breast Feeding

1. Another pregnancy
2. Return of mother to work
3. Lack of education
4. The adoption of western belief that breast feeding in public is immodest.
5. Maternal stress
6. Mental health problems (e.g. postpartum depression, eating disorders)
7. Media portrayal of bottle-feeding as the norm
8. Commercial promotion of infant formula through distribution of hospital discharge packs, coupons of free or discounted formula, and TV and magazine advertising.

CAUTION (WHEN BREAST FEEDING IS NOT ADVISED)

- Maternal exposures to toxins (e.g. Heavy metals, prescribed drugs, drugs, organic chemicals).
- Inborn errors of metabolism (e.g. Galactosemia, PKU-lack of the enzyme phenylalanine hydroxylase)
- Risk of transmission of diseases from mother to infant (HIV/AIDS, Tuberculosis).

4.0 Summary

The Unit dealt with nutrition and the nutrients it contains, children and food, benefit and consequence of not eating good food. It equally talk about the malnutrition, types and signs and ended with cautions when bread feeding is not advised for the children.

5.0 Self-Assessment Questions (SAQs)

(i) define nutrition;
(ii) explain the concept of macro- and micro- nutrients;
(iii) discuss the standards for measuring healthy peoples energy requirements;
(iv) list the 4 various forms of malnutrition;
(v) enumerate the features of kwashiorkor and marasmus;

6.0 Tutor Marked Assessment

Enumerate 5 signs each of 4 different types of malnutrition

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UNIT 2 NUTRITION IN OTHER VULNERABLE GROUPS

Contents

1.0 Introduction

This unit discuss on the effect of food on vulnerable groups (Adolescence and Adulthood), pregnancy, lactation and eating bad habits that causes obesity.

2.0 Learning Outcomes

At the end of this unit, you should be able to:

i. Explain when nutrient intake is said to be compromised
ii. What are the dietary habits recommended during adolescence, adulthood and pregnancy?
iii. List the 3 groups that elderly population is divided into
iv. Explain five of the factors attributed to malnutrition in older groups

3.0 Main Contents

3.1 Nutrition in Adolescence and Adulthood

Adolescence is a time of rapid growth, and the primary dietary need at that period is for energy - often reflected in a voracious appetite. Ideally, foods in the diet should be rich in energy and nutrients. Providing calories in the form of sugary or fatty snacks can mean nutrient intake is compromised, so adolescents should choose a variety of foods from the other basic food groups:

- Plenty of starchy carbohydrates - bread, corn meal, rice, pasta, breakfast cereals, couscous and potatoes
- Plenty of fruit and vegetables - at least five portions every day
- Two to three portions of dairy products, such as milk, yoghurt and pasteurised cheeses
- Two servings of protein, such as meat, fish, eggs and beans

Adolescents are advised against too much fatty foods as well as sugar rich drinks.

Other important dietary habits to follow during adolescence include:

- Drinking at least eight glasses of fluid (preferably water) a day.
- Eating regular meals, including breakfast, as it can provide essential nutrients and improve concentration in the mornings. Choose a fortified breakfast cereal with semi-skimmed milk and a glass of fruit juice.
- Taking regular exercise, which is important for overall fitness, cardiovascular health, as well as bone development.

Not every adult has the same nutritional needs. An adult individual needs to balance energy intake with his or her level of physical activity to avoid storing excess body **fat.** Dietary practices and food choices are related to wellness and affect health, fitness, weight management, and the prevention of chronic diseases such as osteoporosis, cardiovascular diseases and diabetes.

The actual amount of any nutrient a person needs, as well as the amount each individual gets from his or her diet will vary. Many adults do not receive enough **calcium** from their diets, which can lead to osteoporosis later in life. Other nutrients of concern are potassium, fiber, magnesium, and **vitamin E.** Some population groups also need to get more **vitamin B_{12}, iron**, folic acid, and **vitamin D.** These nutrients should come from food when possible, then from supplements if necessary.

As teenagers reach adulthood, the basal energy needs for maintaining the body's **physiological** functions (**basal metabolic rate** or BMR) stabilize, therefore energy requirements also stabilize. BMR is defined as the energy required by the body to keep functioning.

It is important to reduce energy intake at the onset of adulthood, and to make sure that all of one's nutritional needs are met. This can be accomplished by making sure that an adequate amount of energy is consumed (this will vary by body weight, degree of physical fitness, and muscle vs. body fat), and that this amount of energy is adjusted to one's level of physical activity. Foods that are chosen to provide the energy must be highly nutritious, containing high amounts of essential nutrients such as **vitamins, minerals** , and essential **proteins** .

It is usually at this age that young adults start gaining body fat and reducing their physical activity, resulting in an accumulation of fat in the abdominal areas. At the onset of adulthood, energy requirements usually reach a plateau that will last until one's mid-forties, after which they begin to decline, primarily because activity levels and lean muscle mass (amount of muscle vs. body fat), which represents the BMR, decrease. It is believed that the changes in body composition and reduced lean muscle mass occur at a rate of about 5 percent per decade, and energy requirements decrease accordingly. However, these changes in body composition and decreased energy requirements can be prevented by maintaining regular physical activity, including resistance training, which helps maintain lean muscle mass and prevent deposition of excess body fat.

Many adults ignore the role that fluids play in nutrition. Most people will get adequate hydration from normal thirst and drinking behavior, especially by consuming fluids with meals.

Age group	Energy * (kcal)	Protein (g)	Total Fat (g)	SFA (g)	Carbo-hydrates (g)	Dietary fibre (g)	Choles-terol (mg)	Ca (g)	Na (mg)	Fe (mg)	Vit A (mcg)	Folic Acid (mcg)	Vit C (mg)
Men													
18- 29 yrs	2550	68	71	23.6	351	26	300	0.4-0.5	1700	6	750	200	30
30- 59 yrs	2500	68	69	23.0	344	25	300	0.4-0.5	1650	6	750	200	30
60 yrs and above	2100	68	58	19.3	289	21	300	0.4-0.5	1400	6	750	200	30
Women													
18 - 29 yrs	2000	58	56	18.6	275	20	300	0.4-0.5	1350	19	750	200	30
30- 59 yrs	2000	58	57	19.0	275	20	300	0.4-0.5	1350	19	750	200	30
60 yrs and above	1800	58	50	16.7	248	18	300	0.4-0.5	1200	6	750	200	30
Pregnant women													
- full activity	+285	+9	+8	+6	+39	+3	300	1.0-1.2	+200	19	750	400	50
- reduced activity	+200	+9	+6	+2	+28	+2	300	1.0-1.2	+150	19	750	400	50
Lactating women													
- first 6 months	+500	+25	+14	+4.6	+69	+5	300	1.0-1.2	+350	19	1200	400	50
- after 6 months	+500	+19	+14	+4.6	+69	+5	300	1.0-1.2	+350	19	1200	400	50

Legend:

***SFA** - saturated fat; **Ca** - calcium; **Na** - sodium; **Fe** - iron; **Vit A** - vitamin A; **Vit C** - vitamin C*

Please note:

- Recommended energy intakes (*) are for individuals with sedentary to light activity levels.
- The above recommended daily intakes vary depending on physical activity and physiological state of an individual, e.g. pregnancy and lactation.
- The recommended dietary allowanc es are average daily intakes of nutrients over a period of time for the majority of the population. They are not absolute daily dietary requirements.

Nutrition in the aged

The elderly population is divided into 3 age groups

Ages 65-74 referred to as young elderly
Ages 75-84 referred to as the elderly
Ages 85+ referred to as the old old

The aging process shows inter-individual variability in its rate of development. The determinants of the rates of aging of systems and tissues have been reported to be largely genetic. Therefore, premature aging of cells and tissues can occur and is due to genetic factors and to long-term exposure to physical or chemical environments that cause irreversible tissue damage. However, the aging process alters body composition so that nutritional status changes as humans get older. Although the energy needs decrease as people age because lean body mass decreases and levels of physical activity decrease, the chance of meeting the needs of all nutrients also decreases.

Elderly persons are particularly vulnerable to malnutrition. This is because attempts to provide them with adequate nutrition usually encounter many practical problems. According to WHO, the nutritional requirements of the elderly are not well defined, and older person's energy requirement per kilogram of body weight is also reduced because both lean body mass and basal metabolic rate decline with age. Also, the processes of ageing have been reported to affect other nutrient needs. For example, while requirements for some nutrients may be reduced, some data suggest that requirements for other essential nutrients may in fact rise in later life.

Malnutrition in older persons

The prevalence of malnutrition in the aged has been reported to be as high as in children. Many of the diseases suffered by older persons are the result of dietary factors, some of which have been operating since infancy. These factors are then compounded by changes that naturally occur with the ageing process.

Generally speaking, it has been found that there is improper eating as people age. This has been attributed to a number of factors which include:

i. Low income
ii. Lack of knowledge in nutrition
iii. Loneliness
iv. Functional impairment e.g. Depression, Dementia, Drugs, Diseases, Dentition problems, Dysphagia, Diets-restrictive diseases
v. Digestive problems
vi. Gastrointestinal problem such as changes in sense of taste and smell, less secretion of saliva and digestive juices, causing absorption problems and slower movements of the gastrointestinal tract

Another factor is the price of foods rich in micronutrients, which further discourages their

consumption. Compounding this situation is the fact that the older people often suffer from decreased immune function, which contributes to this group's increased morbidity and mortality. Other significant age-related changes include the loss of cognitive function and deteriorating vision, all of which hinder good health and dietary habits.

In the aged, malnutrition could result in one or more of the following:

- Lower quality of life
- Depression
- Increased susceptibility to infection
- Sarcopenia (loss of muscle mass)
- Increased number of falls
- Complications during hospitalization
- Increased tendency for pressure sores
- Increased mortality

Foods which may help promote regular bowel function, and prevent constipation include:

- Fruits
- Vegetables
- Dried fruits
- Whole grain cereals
- Beans
- Plenty of fluid. At least (30ml/kg)
- yogurt

It is also necessary for the aged to engage in some physical activities daily.
Dietary changes seem to affect risk-factor levels throughout life and may have an even greater impact in older people. It is therefore of uttermost importance to give adequate attention to diet during old age.

Nutrition in pregnancy and lactation

The fetus is not a parasite; it depends on the mother's nutrient intake to meet its nutritional needs. Periods of growth and development of the fetal organs and tissues occur throughout pregnancy therefore essential nutrients must be available in required amounts during these times for fetal growth and development to proceed optimally.

Well-nourished women will generally have adequate reserves of nutrients which can maintain delivery of most substrates to the fetal tissues, even if their intakes are compromised in the short to medium term. This is because the delivery of nutrients depends on maternal intake, maternal stores & Placental exchange.

Animal experiments show that under nutrition in utero leads to persistent change in blood pressure, cholesterol metabolism, insulin response to glucose and obesity. The immediate response of a fetus to under nutrition is to break down its own substrates to provide energy. .More prolonged under nutrition leads to growth retardation. Slowing of growth in late gestation leads to disproportion in organ size (e.g. reduced growth of the kidney which is rapidly developed during late gestation).

IMPORTANCE OF BALANCED NUTRITION DURING PREGNANCY

- Optimizes maternal health
- Reduces risk of birth defects
- Reduces suboptimal fetal development
- Reduces chronic health problems in the future

3.2 Obesity

Obesity is defined as an excess of body fat. By using body weight as an index, obesity is a weight greater than 20% more than the average desirable weight for men and women of a given height. Obesity results when there is an imbalance between energy intake and energy expenditure. Obesity is a risk factor for other degenerative diseases, such as type II (adult onset) diabetes, diseases of heart and circulation, and certain cancers.

Causes

1. Over Eating: This may result from primary failure in the regulation of ingesting behavior at the cognitive level. This usually results in excessive caloric intake that exceeds energy needs of the individual.
2. Sex: It is common in women in whom it is liable to occur after pregnancy, especially repeated pregnancies. A woman may gain as much as 12.5kg during pregnancy. Most of this will be in form of adipose store mainly for the demand of lactation. However many women gain more weight and retain part of this weight becoming progressively obese with each succeeding child. Males have a higher resting metabolic rate than females, so males require more calories to maintain their body weight. 3. Age: As a general rule, as you grow older, your metabolic rate slows down and you do not require as many calories to maintain your weight.
4. Environment/Culture: An environment where people eat high fat and high sugar

diets and take little exercise, causes more problems with excess weight and obesity than one where people eat low fat diets and get regular exercise. Cultural belief also contributes to the development of obesity

5. Emotional Factors: Many people over eat when they're stressed, bored or angry. Over time, the association between emotion and food can become firmly fixed. Depression or stress are also causes of obesity and other patterns of disordered eating.
6. Lack of Physical Activity: Lack of physical exercise is definitely one of the major causes of weight gain and obesity.

Techniques and standard for measuring obesity:

Body mass index (BMI): This is calculated by dividing the body mass in kg by square of height in meters. (BMI = kg/m2). The BMI is used to define underweight, overweight and obese individuals.

BMI Categories:

- Underweight = <18.5
- Normal weight = 18.5–24.9
- Overweight = 25–29.9
- Obesity = BMI of 30 or greater

Skinfold thickness Waist/hip-ratios Body Fat Distribution: "Pears" vs. "Apples"

Excessive body fat resulting from an imbalance between energy intake and expenditure is the most important nutritional problem in developed countries and is rapidly becoming a global epidemic; a definition of a healthy diet that fails to address this problem would be deficient. Some well-intended guidelines are highly prescriptive in terms of energy intake or servings per day of each food group. A fundamental problem is that even the healthiest combination of foods consumed in slight excess, by only a percentage or two, over an extended period will lead to overweight.

Case Study

A 25 year old female weighing 68Kg, height of 167 cm and of moderate physical activity has a BMI of 29. Healthy BMI ranges from 18.5 – 24.9, therefore Healthy weight range is 43.3 - 58.5 kg. Based on the current weight, height and activity level, Daily Calorie requirement is **2291 calories**. This is what is needed by this person to maintain the current weight. However, food is not the only thing that affects weight management; exercise or lack of it will impact the amount of calories burned and therefore the net caloric intake. To change your weight by 0.5 kg or 1 lb in one week, you must increase or reduce your net caloric intake by 500 calories per day or 3500 calories per week.

Treatment

A poor diet and lack of exercise are the most common causes of obesity, there are some fairly simple treatments for obesity.

i. Incorporating more natural foods into your diet.
ii. Drinking more water
iii. Cutting out junk food and getting into the habit of exercising several times every week

1.0 Summary

In this unit, we identified the nutrition in adolescent, pregnant women and aged. The issue of overweigh in vulnerable groups was equally looked into as a result of bad food habit. How to measure BMI (body-mass index) was discussed as well.

2.0 Self-Assessment Questions (SAQs)

i. Explain when nutrient intake is said to be compromised
ii. What are the dietary habits recommended during adolescence, adulthood and pregnancy?
iii. List the 3 groups that elderly population is divided into
iv. Explain five of the factors attributed to malnutrition in older groups
v. explain nutrition in the adolescent, pregnant women and the aged; and
vi. discuss the causes measurement and management of obesity

3.0 Tutor Marked Assessment

i. How is the BMI useful in measuring obesity?
ii. What causes improper nutrition in the aged?
iii. Give 4 importance of nutrition during pregnancy
iv. Explain 6 causes of obesity

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Module Twelve

ACHIEVING KNOWLEDGE MANAGEMENT FUNCTIONALITIES IN THE EMERGING TECHNOLOGY-DRIVEN SOCIETY USING INFORMATION TECHNOLOGY

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INTRODUCTION

Knowledge Management (KM) is an emerging concept in the emerging knowledge-driven society. Going by the common saying that "Knowledge is power", decision makers at all levels of organizations are overwhelmed with an avalanche of information on conditions, developments and events that affect both the present and future of our society in this 21st Century (Sondra & Reynold, 2003). The IT approach is forcing it on virtually all organizations to be knowledge-driven (information-driven). However, this module will focus on how to achieve knowledge management functionalities in the emerging technology-driven society using information technology.

Learning Outcomes

By the end of this module, you should be able to:

i. define Knowledge Management (KM) and IT;
ii. explain the concept, scope and application of Knowledge Management (KM) functionalities;
iii. discuss the Evolution of Modern Information Technology (IT);
iv. determine relevant IT for achieving each of the KM functionalities; and
v. explain the use of Workflow and Groupware and their benefits to organizations.

Main Body

Introduction

There are two units in this module:
Unit 1: Knowledge Management Tools
Unit 2: Achieving Knowledge Management System Functionalities

UNIT 1: KNOWLEDGE MANAGEMENT TOOLS

Contents

1.0 Introduction

This unit will introduce you to knowledge management tools. However, before going into knowledge management tools, you need to first understand the concept of knowledge management and its scope.

2.0 Learning Objectives

By the end of this unit, you should be able to:
i. Define the concept of knowledge management,
ii. Describe at least 3 knowledge management tools,

3.0 Main Contents

3.1 The Concept of Knowledge Management

Knowledge Management (KM) involves strategies and applications that are geared towards creating, documenting and sharing knowledge, both tacit and explicit, for productivity and sustainability in organizations. KM is very important because it helps organizations to gain competitive advantage and effective working through sharing and re-using knowledge. In the market place of e-business, KM initiatives are used to systematically leverage information and expertise to improve organizational responsiveness, innovation, competency and efficiency. There are many reasons why knowledge should be managed properly; especially using the collaborative technology. Among these are information overload, technology advancement, increased professional specialization, competition, workforce mobility and turnover, and capitalization of organizational knowledge.

KM is technologically achieved in a process described as Knowledge Management System (KMS). KMS is a facilitator that helps in the integration of the phases of the management process through the employment of electronic media, like personal computers, server, networks and software. Figure 1 illustrates KMS with the input devices, repositories, intelligent retrieval tools, and display or output devices interconnected through the utilization of electronic network since the KMS mostly operate in such a network.

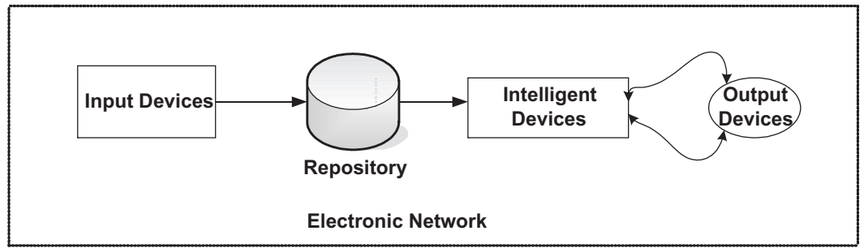

Figure : KMS Components in electronic network

1.1 Knowledge Management Tools (KMT)

In order to fully implement a knowledge management system (KMS) and derive the maximum benefits, there is need to provide two elements: *(i) A technological infrastructure composed of computers, networks and databases; (ii) Software applications installed in distributed environments.* These two elements are usually referred to as knowledge management tools (KMT). These tools are designed and built to enable easier and faster use of important functionalities, such as document management, collaborative online workshops, and superior search engines that are essential for the management, safeguarding and harnessing of knowledge. The effective deployment of these tools within a KM system can improve collaboration and working environment, enhance competitive advantage and responsiveness, and increase overall productivity.

The KM tools are used to create, organize and share the knowledge that can be found, most of the time, in a document, a project report, or a memo from one employee to another. There are a number of software applications that are able to create a web of repositories, search engines and virtual spaces, where knowledge can be stored, retrieved and shared. An ideal KM tool must include features like mobility that allows users to interact with the system from any place at any time; even as it is important to maintain an updated compact disk that can be used offline whenever a network connection is not available.

1.2 Types of Knowledge Management Tools

Three are various types of KM tools that can help knowledge management fulfill its goals. This section deals with various types of KM tools available on the market today and their roles in the KM process. This is very important since there are thousands of options to choose from.

3.3.1 Groupware

Groupware refers to technologies and applications designed to help people collaborate in order to facilitate the work of groups. Groupware is a collaboration tool, and it includes a wide range of applications that may be used to communicate, cooperate, coordinate, solve problems, compete, or even make negotiations. Collaboration resembles a large meeting room in which colleagues work together, even over long distances or at different times of the

day. They share opinions, calendars and projects. A collaborative environment enables people to work in secured online workspaces, in which they use e-mail, Internet web browser and desktop applications in order to share knowledge, build closer organizational relationships and streamline work processes. Such an environment also encourages employees to share information in open discussion forums, thereby providing access to tacit knowledge. Moreover, collaboration tools offer better user interface for internal and external users, thus providing the link between the organization and its partners and customers the following are three categories of groupware:

- **Communication tools,** for sending messages and files, including email, web publishing, wikis, files haring, etc.
- **Conferencing tools,** video/audio conferencing, chat, forums, etc.
- **Collaborative management tools,** for managing group activities, e.g. project management systems, workflow systems, information management systems, etc. (Frost, 2014)

3.3.2 **The Intranet**

The intranet is essentially a small-scale version of the Internet, operating with similar functionality, but existing solely within the organization/firm. Like the Internet, the intranet uses network technologies such as Transmission Control Protocol/Internet Protocol (TCP/IP). It allows for the creation of internal networks with common Internet applications that can allow them to communicate with different operating systems. The intranet can be a very useful tool in the KM process. It allows for the integration of multimedia communication and can act as a platform for groupware applications and publishing. It is intended to enhance collaboration, productivity, and socialization, but also to influence organizational culture and to act as a repository for embedded knowledge. The intranet homepage performs roles such as news, navigation, key tools, key information, community and culture, internal marketing and collaboration. Its focus is to provide a useful site that enhances work practices, communicates key information, provides the right navigation tools, and helps define organizational culture. Its objectives will also vary, depending on the individual business, and may focus more on certain aspects than others. Perhaps the most important function of the intranet is knowledge sharing and collaboration. The main functions supporting this are:

- **Publishing:** homepages, newsletters, documents, employee directories.
- **Searching:** The intranet can integrate different search functions, e.g. through a search engine or using a system of categorization.
- **Transacting:** Allows user to make transactions with other web/intranet homepages.
- **Interacting:** Collaborative applications and other groupware, expert finders, directories, etc.
- **Recording:** It can be used as a storage medium for such elements as procedures, best practices, and FAQs (embedded and explicit knowledge) (Frost, 2014)

3.3.3 The Extranet

The extranet is an extension of the intranet to the firm's external network, including partners,

suppliers and so on. The term is sometimes used to refer to a supplementary system working alongside the intranet or to a part of the intranet that is made available to certain external users. The extranet provides a shared network with limited, controlled access to organizational information and knowledge resources, and uses security protocols, such as authentification, to limit access. An extranet can enhance collaboration and information transfer with partners in the external network. Security is a key concern, and a firm must protect its crucial knowledge and information resources. This can be done using firewalls, use of encryption, and simple or strong authentification. Simple authentification involves usernames and passwords, while strong authentification makes use of digital certificates. The content of both intranets and extranets is usually managed with a content management system (Frost, 2014).

3.3.4 Enterprise 2.0., KM 2.0 and the Emergence of Web 3.0

In recent years, the term web 2.0 has appeared to describe the increasingly popular tools that promote two way communications on the Internet. These social tools include blogs, wikis, social bookmarking, commenting, shared workspaces, micro blogging and polling. They differ from traditional publishing in that they "put the knowledge sharing power in the hands of the users themselves". The web 2.0 tools that have been applied within organizations, especially profit-oriented types, have been called enterprise 2.0, and even more recently, the mapping of these principles to KM has been dubbed KM 2.0. The values of KM 2.0 are many. Web 2.0 tools facilitate the development of social capital through knowledge sharing, which in turn increases the potential to create intellectual capital. Social capital is the total resources existing across social networks (Cronk, 2011; Frost, 2014).

There is also the emergence of web 3.0. Web 3.0 is a product of continuous evolution of the Internet and web applications. It is the extension of web 2.0 and the third generation of the web, involving connective intelligence, connecting data, concepts, applications and ultimately people. Spivack (2015) sees web 3.0 as third-generation of the Web enabled by the convergence of several key emerging technology trends:

- **Ubiquitous Connectivity, involving b**roadband adoption, mobile Internet access and mobile devices.
- **Network Computing – s**oftware service business models, web services interoperability, and distributed computing.
- **Open Technologies - o**pen apps and protocols, open data formats, open-source software platforms, open data (creative data, open data licences, etc.)
- **Open Identity - o**pen identity, open reputation, portable identity and personal data (for example, the ability of a user to port account and search history from one service to another).
- **The Intelligent Web - s**emantic web technologies, semantic application platforms, and statement-based datastores and associative databases, distributed databases, intelligent applications (natural language processing, machine learning, machine reasoning, and autonomous agents).

3.3.5 Data Warehousing, Data Mining, and On-line Analytical Processing (OLAP)

Warehousing data is based on the premise that the quality of a manager's decisions is based, at least in part, on the quality of his information. The goal of storing data in a centralized system is thus to have the means to provide them with the right building blocks for sound information and knowledge. Data warehouses contain information ranging from measurements of performance to competitive intelligence. Data mining tools and techniques can be used to search stored data for patterns that might lead to new insights. Furthermore, the data warehouse is usually the driver of data-driven decision support systems (DSS)

Thierauf (1999) describes the process of warehousing data, extraction, and distribution. First data extraction of operational production data takes place, and this data is passed on to the warehouse database. A server hosts the data warehouse and the DSS. This server then passes on the extracted data to the warehouse database, which is employed by users to extract data through some form of software.

3.3.6 Decision Support Systems

The role of these systems is to access and manipulate data. They usually work with a data warehouse, use an online analytical processing system (OLAP), and employ data mining techniques. The goal is to enhance decision-making and solve problems by working with the manager rather than replacing him. A decision support system can be a valuable tool. However, in order to be able to provide the information that each expert would find relevant, the user must be involved in the development and the post audit evaluation of the decision support system. This involvement must span not just the content issues, but also the presentation and the organization of the information. This is necessary to ensure that the system fulfills the three criteria that determine its success, namely compatibility, understandability, and effectiveness. If these criteria are met, the DSS can be invaluable in expanding the scope of information that each expert can handle. As a result, cognitive limitations become less important in determining the amount of source materials that the expert can use (Frost, 2014)

3.3.7 Content Management System

Content management systems (CMS) are very relevant to KM because they are responsible for the creation, management, and distribution of content on the intranet, extranet, or a website. Content management is a discipline in itself; and a CMS may have the following functions:

- Provide templates for publishing: Making publishing easier and more consistent with existing structure/design.
- Tag content with metadata: i.e. allowing the input of data that classifies content (e.g. keywords) so that it can be searched for and retrieved.
- Make it easy to edit content
- Version control: Tracking changes to pages and, if necessary, allowing previous versions to be accessed
- Allow for collaborative work on content

- Integrated document management systems
- Workflow management: Allowing for parallel content development

The CMS comes in different forms (and prices), and an organization must carefully evaluate what it needs. The following are six general factors for consideration:

- **Technology:** Including dynamic versus static publishing, high load performance, security issues, and search engine ranking factors (static pages rank better).
- **Ease of use:** Most users are non-technical. Therefore, it is important to assess the ease of use of the end user content editing interface, the template-building interface, and the content approval system.
- **Total cost of ownership:** I.e. the costs in the long run, including maintenance and applications.
- **Cross Platform Support and Scalability:** Can it handle multiple operating systems? Can it integrate with other server side technologies?
- **Web Presence Management:** The system should allow for the management of different websites separately and securely so as to manage multiple web presences (e.g. site on the intranet versus site on the extranet). (Frost, 2014)

3.3.8 Document Management System

Document management systems, as the name implies, are systems that aid in the publishing, storage, indexing, and retrieval of documents. Although such systems deal almost exclusively with explicit knowledge, the sheer volume of documents that an organization has to deal with makes them useful and in some cases even mandatory. Often they are a part of the CMS. Usually, a document management system will include the following functions:

i. **Capturing:** In order for paper documents to be useable by the document management system, they must be scanned in. For companies that need to carry out this process and who have numerous paper documents this may be time consuming and expensive.

ii. **Classification using metadata:** Metadata (data about data) is used to identify the document so that it can be retrieved later. It can include keywords, date, author, etc. The user is often asked to input this metadata or the system may extract it from the document. Optical character recognition may be used to identify text on scanned images.

iii. **Indexing:** There are many different forms, and a good indexing system is crucial. The index function will use metadata.

iv. **Searching and retrieval:** The document management system's search function is one of its most important elements. Search functions can be more or less sophisticated, allowing for searches by elements of the document's metadata, or by searching the actual document for key words/phrases and using semantic analysis to determine relevance.

v. **Versioning:** Storage and management of different versions of documents - useful for documents that require frequent updating. Allows authorized users to return to earlier versions.

vi. **Administration and security:** Any IT system needs to be regulated and policed. Users require different levels of authorization, with certain more sensitive functions/documents being available only to selected users/administrators. Document management systems will also have backup systems in place in case of mishaps (Frost, 2014).

2.0 Summary

This unit examined knowledge management tools, technologies and systems for organizations in the knowledge economy. An understanding of the concepts: Knowledge management and its tools were explored, including their categorization. Groupware Intranet, Extranet, Enterprise 2.0, Knowledge Management 2.0, Data Warehousing, Data Mining and Online Analytical Processing were discussed. Decision support systems, content management system, document and knowledge management systems were discussed.

3.0 Self-Assessment Questions (SAQs)

i. Define the concept of knowledge management (KM)
ii. Identify and describe five (5) types of knowledge management tools.

4.0 Tutor Marked Assessment

i. What is knowledge management system (KMS)?
ii. State 5 functions of document management system

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UNIT 2: KNOWLEDGE MANAGEMENT SYSTEM FUNCTIONALITIES

Contents

1.0 Introduction

In this unit, you will learn about different KMS functionalities (searching, categorizing, composing, and summarizing) as well as the appropriate technologies that drive them in this knowledge-driven society.

2.0 Learning Objectives

By the end of this unit, you should be able to:

i. describe the application of knowledge management (KM) functionalities,
ii. determine the relevant technologies for achieving each of the KM functionalities
iii. explain 7 categories of search engines

3.0 Main Contents

3.1 Knowledge Management System Functionalities

KM objectives are achieved via its functionalities. The following are KM functionalities:

i. **Searching:** This entails looking for needed information in a huge store/repository of information. The highly voluminous organizational data in the emerging e-society calls for an efficient searching technology/tool that is capable of easy access to information. Since most of this information is web-based, Web search engine tool therefore proved to be the best in this regard. The web search engine technology has its roots in Information retrieval (IR) systems originated by Hans Peter Luhn`s at the IBM during the late 1950s. According to Poremsky (2004) a web search engine can be defined as a tool that lets you explore databases containing the text from hundreds of millions of WebPages. When the search engine software finds much of the search request (often referred as hits), then it presents them with a brief descriptions and clickable links.

ii. **Categorizing:** In KM, knowledge requires to be categorized to make it more useful. Since the size and type of available information accumulates with time, a design of "Information Architecture" need be created for easy sorting of information. One mode

of achieving this is to sort them according to the file format into which the information entry was made and saved (Riley, 2003) for example, Word processors, Spreadsheets, data tables and so on. Each of these software tools has different format, features and functions.

iii. **Composing:** KM is characterized with creation of new knowledge from existing information. Composing entails creating new documents. Microsoft Office Suite Applications are re-known tools for composing functionality of KM and it offers applications such as word processing, calculations and management of data.

iv. **Summarizing:** Summarizing is an essential functionality of KM since it is easier to work with summarized information than the full information. However, this requires some level of competence since no vital information should be left out in the process.

v. **Storing:** In every organization, storing and seeking information are extremely important and crucial. This need necessitated the need of electronic storage medium. Storing this information is very important in the emerging knowledge society. Information Systems revealed the utilization of hard-wired data inputs and output like long printed scrolls of papers. Unfortunately neither the input nor the output could cope with huge amounts of generated data in this era.

vi. **Distributing:** KM emphasizes sharing of knowledge for certain economic benefits. Sharing knowledge thus requires distributing such knowledge across a computer network. "Distributing information can be done either openly as on the Internet, exclusively over an Intranet, or in some combination of the two as with an Extranet". Network is a set of devices "sometimes called nodes, or stations interconnected by media linking equipments.

vii. **Workflow:** Workflow is the established flow of information among knowledge workers. It is a major determinant of success in KM. It has direct implication on the performance of workers. In the past information processing steps were basically handled manually using exchange of documents among members of the organization. Such experience was tiring and time consuming. The concept of workflow was then invented to address this problem. Workflow is used in organizations to illustrate the tasks, routine or procedural steps, data input, information and feedback output, involved people and even tools required for each step in business process. This is where the concept of "paperless office" originated.

3.2 KM Functionalities and Technologies

KM objectives are achieved via its functionalities as shown in Table 1. The following discussion will center on those functionalities and the technologies driving them.

Table 1: KM Functionality and Technology

Functionality	**Technology**
Searching	Search engines
Categorising	Computer Languages
Composing	Office Suite Applications
Summarising	Artificial Intelligence
Storing	Storage Media
Distributing	Networks
Workflow	Groupware

3.2.1 Searching and Search Engines:

In Knowledge Management, achieving a complete and successful search of required information in a timely and reasonably priced approach is a major challenge. Search Engines are tools developed to address these challenges. Usually sizable databases and websites possess their own Search Engine; therefore it is made possible that searchers can easily log on and then type their inquiries in the search box. In addition to that, there are free Search Engines accessible from the World Wide Web. Search engines can be classified into seven categories (Knowledge Management Resource Center (KMRC), 2008) and they are as follows:

(1) **Special Search Engines:** As the name implies, this category of search engines are designed for general purpose to cater for people of diverse information needs.

(a) ***Ask Jeeves*** (http://www.ask.com/): is a unique search engine that allows users to ask questions in simple English. The secret lies that it combines a natural language engine with a proprietary knowledgebase which gets smarter with the change of time.

(b) ***Google (***http://www.google.com/***):*** This search engine offers pre-defined search leading to over 1,090,000 pages. It is referred to as a selective search engine. Google emphasizes that, in developing sites, the popularity of the links from other sites

(2) **Directory Searches for KMt:-** This works with pre-defined categories.

(a) ***Yahoo (***http://www.yahoo.com/***):*** This search engine offers KM resources that are listed in categories that are pre-defined, plus more than 1,160,000 subscribers.

(b) ***LookSmart (***http://www.looksmart.com/***):*** It includes a search engine and as well a category-based portal, but without search result counts.

(c) ***About.com (Directory) (***http://www.about.com/***):*** This search engine offers wide subject areas and searches across all of the subject areas.

(3) **Knowledge Management Category Searches:** This deals with categories that are not pre-defined.

(a) ***AltaVista (***http://www.altavista.com/***) :*** This is considered as one of the web's most powerful search engines. It supports a pre-defined Knowledge Management search that leads more than 574,000 pages.

(b) ***Business.com ():*** This search engine offers a category recognized currently as the foremost business search engine and its business directory made to help its users find information such as companies, products, services, etc.

(c) ***Teoma (***http://www.squirrelnet.com/search/Teoma.asp*):* It offers methods that help users refine their search and search results. It also provides link collections.

(d) ***Hotbot (***Categoryhttp://www.hotbot.com/***):*** This is regarded as well respected search engine that provides more than 16,348,000 pages listed in a recent search. It as well offers a dedicated Knowledge Management

(4) ***Open Directory-Directory:*** This category of search engine and people recommend all the entries. Users looking for information about Knowledge Management can search across all categories or can specifically check the Knowledge Management category.

(a) ***Netscape Netcenter*** (http://search.netscape.com/search/webhome)***:*** This search engine provides special category for locating KM resources, with the provision of subtopics for knowledge discovery and creation.

(b) ***Lycos*** (http://www.lycos.com/)***:*** This eearch Engine offers a relevant area about Knowledge Management with accompanying subcategories such as companies, creation of knowledge and publications etc

(5) **Web Searches for Knowledge Management:-** This category of search engine contains tools used form mining the web-based knowledge.

(a) ***Excite (***http://www.excite.com/***):*** It offers search that covers Pre-defined Knowledge Management.

(b) ***Euro Seek*** (http://www.euroseek.com/) ***:*** This is an European search engine that allows users to search for Knowledge Management topics in 25 languages and covering 43 countries. It is a Pre-defined search for the Knowledge Management in the United Kingdom.

(6) **Meta Search Engines:** This category of search engine is primarily designed for data mining.

(a) ***Gotcha MetaKM*** (http://www.icasit.org/km/resources/portals.htm)***:*** This is a portal that offers KM resources: KM Websites - Portal Sites and it is the under the Intentional Center for Applied Studies in Information Technology (ICASIT) at the George Mason University. It provides a compilation of KM portals and as well as resources that are very helpful to academics and industry practitioners and researchers.

(b) ***Dogpile(***(http://www.dogpile.com/)***:*** This search engine is considered to be a remarkable just like Google and it fetches for users top results from other 15 search engines.

(7) **Meta Search Sites:** These are web sites purposely for searching purposes.

BeauCoup (http://www.beaucoup.com/***):*** This tool is not a Pre-defined KM search; instead it is a metasearch site that offers accompanying links of almost 70 Search Engines. It is different from Dogpile since it doesn't offer searching the Engines for users.

Apart from the aforementioned seven categories, Glossbrenner and Glossbrenner (2001) revealed five Specialized Search Engines as follows:

i) **Deja**: here, users can search (recent newsgroup postings (one month's worth) and Usenet newsgroup archives including the older postings that date back to May 1999).

ii) **Topica:** with this search engine, one can search for directory of over 90,000 mailing list and message archives for public lists.

iii) **Argus Clearinghouse:** users can search for directory of subject-specific guides to the internet resources, which were prepared by subject-matter experts. The directory is being revived and rated by information and library studies professionals.

iv) **Info space**; This engine is people –finding tools and it can be used to search world-wide email directory, telephone directory that lists the residents living in USA , Canada, and Europe and as well celebrity directory (athletes, authors, journalists, movie stars, etc.)

v) **Zip 2 for business searches;** It offers directory of US business which is searchable by name and business type. Zip 2 also offers database of maps and driving directories.

3.2.2 Categorizing and Computer Languages:

A completely new mode of sorting information is based on the semantics of the content and this is accomplished in three ways; namely:

1. Key words in titles,
2. Word-count frequency in the body of the content, and
3. Graphics meanings.

The file format and semantic content sorting modes have no basic and essential relationship between them. Unfortunately, the adoption of either of the two modes for categorization, process results in information loss, which is undesirable in KM. This is where computer languages come in. The loss is overcome by introducing the new available computer languages such as the eXtensible Markup Language (XML), which can be defined as "a system for defining, validating, and sharing document formats" (Tittel, 2002). The suitability of XML here can be traced to its ability to create a meta-data.

3.2.3 Composing and Office Suit Applications:

This offers applications such as word processing, calculations and management of data. Each application has its own software tools. These include:

(i) **Microsoft Word** is a powerful tool that can be used to create professional documents.
(ii) **Microsoft Excel** users can generate detailed spreadsheets for viewing and collaboration.
(iii) **Microsoft PowerPoint** offers an entire set of tools for that can produce excellent presentations.
(iv) **Microsoft Access** provides for the users powerful database management system; that means users can manage their data. Microsoft Access is regarded as the best personal database management tool.
(v) **Microsoft Publisher** This tool helps user easily generate, modify, and publish materials such as newsletters, Web sites, flyers, brochures, and catalogs.

The design of all the office suite applications has a common look and feel, which creates uniform or same labeling and location of buttons throughout word processor or spreadsheet. If office suite applications are user friendly and well improved, then they can significantly contribute to Knowledge Management.

3.2.4 Summarizing and Artificial Intelligence

In KM, Artificial Intelligence (AI) at present offers an answer for the document overload problem. For example people who create abstracts of documents such as articles and

executive summaries of books have already realized the fact that documents have got only 20% or even less that as the core content message (The importance and aims of the document in brief). The rest of the document is just an explanation of the core content and illustrative examples. Nowadays it is possible to reduce documents down to 50%, or 25%, or 10%, or even 5% of their original length and these summarizing techniques have been realized through development of algorithm. Currently major word processors have got such intelligent algorithms imbedded in them and that is why can support summarization of information. However, they can only summarize documents based on their own format.

Today commercial summarizers can analyze a text of any length, on any subject, and can generate both short and long summaries of the document as the user wishes. They can summarize Word documents, Web pages, PDF files, email messages and even text from the Clipboard. These summarizers employ sophisticated statistical and linguistic algorithms. The summarizer will almost certainly demonstrate to be the most important instrument for personal efforts in KM.

3.2.5 Storing and Storing Media

Ultimately, the introduction of **Magnetic Tape** was realized and it became the choice of storage media for large volume of data. Up to the present day, magnetic tape is used as a secondary medium (archival storage, PCs backup and other systems storage) in business organizations. It is true that sheer amount of data users need to access huge data kept in Data Warehouses, However, tape storage is changing and it is moving beyond backup. One of the other growing magnetic tape business applications is the 36-tack magnetic tape cartridges in robotic automated drive assemblies. This technology can directly access large number of cartridges, in fact amounting more than hundred. It offers cheaper storage that can complement magnetic disks to cover the storage demand of large data warehouse and other online business needs.

The arrival of smaller computers known as mini, micro, desktop, or personal computers had created the need for cheaper and compact storage**. Magnetic Disks** are recognized as the most common type of secondary storage media, the reason being that they offer fast access and high storage capacities at a reasonable cost. In fact there are several types of Magnetic Disks, but they can generally be categorized into two: removable disk cartridges and fixed disk units. Examples of these Magnetic Disks technologies include floppy disks (1.44 megabytes of storage area) and Hard disk drives (offers higher speeds, and large data recording densities).

Optical Disks are secondary storage medium technologies utilizing compact disks (CDs) and digital versatile disks (DVDs). Optical disks have become very important technologies since most the companies use CD-ROM to distribute their programs. Many organizations use this technology to distribute products and corporate information that once used to fill cabinets of book shelves.

In knowledge management, it is of primary importance that different generations of storage media need "universal viewers" to make their content available in spite of the obsolescence of their formats. It is true that currently CDs, DVDs, Floppy and other storage devices are

facing the prospect of possible obsolescence. If so, then with strategized application of XML in the future is expected to answer and offer the basic solution for this problem.

3.2.6 Distributing and Networks

Data communications networks are systems of interrelated, interconnected devices like computers and computer equipment. For example, a simple as a personal computer (PC) connected to another PC or connected to a printer by media link or a large and complex public telephone network, where millions of telephones are interconnected. The networks can be wireless or wired. It can be positioned on ordinary carriers such as telephone lines. The networks can be separated from the external environment by firewalls for security purpose.

To create effective network for KM, the network must be supported by high bandwidth thus enabling the transmission of data, text, voice and multimedia concurrently. Such network is referred to as broadband, that is, a wide bandwidth capable of transporting multiple signals and traffic types simultaneously. When implementing broadband networks that support KM system, it is important to consider the location as this will determine what kind of physical medium connections used such as wired or wireless to use. The following are the main means of connections:

1. Telephone dial up(modem)
2. A number of high speed phone lines, examples are, ISDN, DSL, and T1
3. Cable Modem; and
4. Wireless, the satellite and other airborne links.

3.2.7 Workflow and Groupware

Groupware can be defined simply as a tool that helps people to work to together more easily and efficiently. It allows communication, coordination, and collaboration. Terms like collaborative computing, or Group Support Systems (GSS) also refer to groupware. The use of groupware in organizations supports the free flow of information, which in turn results improved innovation and facilitated collective leadership. Groupware is so important because it offers considerable benefits over single-user systems. Some of which include:

- facilitating communication: making it faster, clearer, more persuasive
- enabling communication where it wouldn't otherwise be possible
- enabling telecommuting
- cutting down on travel costs
- bringing together multiple perspectives and expertise
- saving time and cost in coordinating group work
- facilitating group problem-solving

4.0 Summary

This unit discussed different varieties of KM functionalities as may be applicable in various

disciplines of human endeavor with appropriate technologies that drive them. This will make it easier for you to choose appropriate technology for the desired KM functionality. Since, computer and associated technologies have taken over virtually all operations, it is then desirable for all to get familiar with relevant IT to cope with the emerging demands as dictated by the new technological innovations.

5.0 Self-Assessment Questions (SAQs)

1. Describe any five (5) KM functionalities you know.
2. Identify and explain any five (5) appropriate technologies that can be used to achieve KM functionalities.
3. List 3 categories of search engine

6.0 Tutor Marked Assessment

i. Define Artificial Intelligence
ii. Explain 4 means of communication connections
iii. Differentiate between optical disk and magnetic disk storage medium

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Module Thirteen

SCIENCE AND TECHNOLOGY IN THE SERVICE OF MAN

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INTRODUCTION

Science and Technology are of paramount importance to man. Science means knowledge, it is a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe. Today, technology seeks to improve productive.

Learning Outcomes

By the end of this module, you should be able to:

i. explain 3 roles of science;
ii. write a brief note on the history of science;
iii. list with examples, 5 categories of activities branded as science;
iv. Explain how technology has developed man; and
v. Discuss the side effects of technology to man and his environment.

Main Body

Introduction

This module covers the role of science, history of science, scientific methodology, effect of science on man and technology revolution of 21st century. This module is split into a unit and 3 subunits for easy teaching and learning.

Unit 1 Meaning and Roles of Science

Subunit 1 History of Science
Subunit 2 Methodology of Science
Subunit 3 Effects of Science on Man

UNIT 1: MEANING AND ROLES OF SCIENCE

Contents

1.0 Introduction

Science and Technology are of paramount importance to man. Science means knowledge, it is a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe. Today, technology seeks to improve productive. This unit covers the role of science, history of science, scientific methodology, effect of science on man and technology revolution of 21st century.

2.0 Learning Outcomes

At the end of this unit, you should be able to:

i. explain 3 roles of science;
ii. write a brief note on the history of science;
iii. list with examples, 5 categories of activities branded as science;
iv. Explain how technology has developed man; and
v. Discuss the side effects of technology to man and his environment

3.0 Main Content

3.1 Meaning and Roles of Science

Science is the totality of man's investigation about events in his environment. His mastery of the environment a consequence of his investigations, lead to answers to questions about the world around him such as those involving the geometry of the earth, the structure and contents of the atom, the origin of man which have been tasking the intellect of man from one generation to the other.

Equally stimulating is the curiosity of man about interpersonal behaviours and commodities demand and supply profiles. Answers to these questions have varied in form over the years. For example, while Dalton theorised the indivisibility of the atom, a later generation scientist theorised the divisibility of atom, thus extending the frontier of knowledge further.

Rather than contradicting ideas before it, each new idea is seen as a new discovery necessitated by observational and analytical technologies available at the time of investigation.

One thing is clear about the roles science is playing in our life; it separates the primitive man

from the modern man. These terms can be relative but the following can be said, without any fear of contradiction, about science:

I. It broadens our horizon about events around us and thus improves our comprehension of the environment of our abode;
II. It replaces superstition, myths and taboos with facts obtained from data and tests, thereby liberating man from the fear of unknown; and
III. Each new discovery emboldens and encourages man to search for more.

To ensure that we actually master the environment, there is the need to be able to make general statements or claims that have the potential of becoming rules or laws if legitimate. To make such statements, there is the need to scrutinise the facts obtained. Some school opines that for such general statements to be legitimate, the following are necessary;

a. The number of observation statements forming the basis of a generalisation must be large
b. The observation must be repeated under variety of condition
c. No accepted observation statement should conflict with the derived universal law.

There is, therefore, an underlying assumption that space and time are real, have dimensions and are continuous. Not only that, every event has a cause.

3.2 History of Science

The desire of man to master his environment and the events therein is as old as man himself. However, methodology has varied from one generation to the other.

In prehistoric times, technique and knowledge were passed from generation to generation in an oral tradition. For example, the domestication of maize for agriculture has been dated to about 9,000 years ago in southern Mexico, before the development of writing systems. Similarly, archaeological evidence indicates the development of astronomical knowledge in preliterate societies. The development of writing enabled knowledge to be stored and communicated across generations with much greater fidelity..

Egypt

The ancient Egypt made noteworthy advances in astronomy, mathematics and medicine. The Edwin Smith papyrus is one of the first medical documents still extant, and perhaps the earliest document that attempts to describe and analyze the brain: it might be seen as the very beginnings of modern neuroscience.

Greco-Roman world

The ancient people who are considered the first *scientists* may have thought of themselves as *natural philosophers*, as practitioners of a skilled profession (for example, physicians), or as

followers of a religious tradition (for example, temple healers).

The earliest Greek philosophers, known as the pre-Socratics, provided competing answers to the question found in the myths of their neighbors: "How did the ordered cosmos in which we live come to be?" The pre-Socratic philosopher Thales (640–546 BC), dubbed the "father of science", was the first to postulate non-supernatural explanations for natural phenomena. For example, that land floats on water and that earthquakes are caused by the agitation of the water upon which the land floats, rather than the god Poseidon. Thales' student Pythagoras of Samos investigated mathematics, and was the first to postulate that the Earth is spherical in shape.

Subsequently, Plato and Aristotle produced the first systematic discussions of natural philosophy, which did much to shape later investigations of nature. Their development of deductive reasoning was of particular importance and usefulness to later scientific inquiry.

The important legacy of this period included substantial advances in factual knowledge, especially in anatomy, zoology, botany, mineralogy, geography, mathematics and astronomy; an awareness of the importance of certain scientific problems, especially those related to the problem of change and its causes; and a recognition of the methodological importance of applying mathematics to natural phenomena and of undertaking empirical research.

The scientific revolution of the seventeenth century fired the desire to know more and the courage to ask questions the more. Hence, the erroneous reference, by some, to this period as the beginning of the scientific era.

3.3 Methodology of Science

This is a method of research in which a problem is identified, relevant data are gathered, and hypothesis is formulated and empirically tested. The scientific method approach is used in all areas of scientific research, such as, natural science, earth science, social science, behavioral science and so on.

The stages are five and a feedback stage:

(i) Make an observation.
(ii) Ask a question.
(iii) Form a **hypothesis**, or testable explanation.
(iv) Make a prediction based on the hypothesis.
(v) Test the prediction.
(vi) Iterate: use the results to make new hypotheses or predictions.

Example:

I. Make an observation.

Plug the television to a power outlet and power it up; however, your television does not start.

2. Ask a question.
Why is my television not coming up?

3. Propose a hypothesis.
A *hypothesis* is a potential answer to the question, one that can somehow be tested. For this case the hypothesis could be that the television didn't start because the electrical outlet is broken.

4. Make predictions.
A prediction is an outcome expected to see if the hypothesis is correct. In this case, we might predict that if the electrical outlet is broken, then plugging the television into a different outlet should fix the problem.

5. Test the predictions.

To test the hypothesis, we need to make an observation or perform an experiment associated with the prediction. For instance, in this case, we would plug the television into a different outlet and see if it starts.

- If the television does start, then the hypothesis is supported—likely correct.
- If the television doesn't start, then the hypothesis is not supported—likely wrong.

The results of a test may either support or contradict a hypothesis. Results that support a hypothesis can't conclusively prove that it's correct, but they do mean it's likely to be correct. On the other hand, if results contradict a hypothesis, that hypothesis is probably not correct. A contradictory result means that we can discard the hypothesis and look for a new one.

6. Iterate.

The last step of the scientific method is to reflect on our results and use them to guide our next steps.

3.4 Scope of Science

The scope of science is wide and it is growing

Natural Science	**Social Science**	**Behavioural Science**	**Earth Science**
Biology	economics	psychology	geology
Chemistry	Archaeology	sociology	geography
Physics	Politics		

Note that subdivision exist and the list is not rigid

3.5 Effects of Science on Man

The idea that knowledge can be acquired only through a process enumerated in science seems to suggest any idea, event or process that cannot be so investigated does not exist in the realm of reality. This has a lot of implications on many activities of man. To a large extent, man is emboldened to seek for more knowledge. This includes raising questions about the creation and existence of man and the myths of the deity connection. Here lies the so called conflict between science on one hand, religion and tradition on the other. The effects of science on human can be seen in different areas such as:

I. Technology
II. Occupation structure
III. The operation of economy
IV. Spatial structure
V. Culture

3.5.1 Technology

Science broadened man's intellectual horizon about his environment, thus preparing him to dominate it and put in into use to satisfy his ever-increasing desires of life. This is what technology is all about.
Technology is as old as man. The early man used stones to kill animals both for protection and for food. He made fire, and cooked with it, from raffia palm. He protected himself from cold weather using leaves. He provided health care services for himself from provided social entertainments. He moved from one place to another in search of wants. He communicated and finally, he enjoyed himself within the limit of his ability.

The arts of palm wine tapping, basket making. Trap making and selling of animal traps, black soap making, dyeing as were practised by ancient Africans were technologies in their own right. The present accounting system and Boolean algebra have a precursor in the recordings of esusu a contributory scheme where the contributor made marks on the wall.

Essentially, what the so called modern technology sought to achieve are;

I. To produce on a large scale to meet an increasing population and so demand
II. To shorten work duration thereby allowing for leisure

Today, technology is severally referred to as modern technology, scientific technology or knowledge based technology. In the true sense of it, modernism is not a static parameter. For as long as perfection is not attained technology will continue to change form. For example, the requirement of portability and so miniaturisation in electronics make use of integrated circuits a better alternative to the discrete circuits of the earlier generation etc. The process is continuous.

Technology has developed man in many ways, which include:

I. Food and agriculture: mechanised farming replaced the traditional method, enhancing cultivation of larger areas over shorter period of time, yielding more products.
II. Transportation: foot has been replaced with transportation by motor vehicles on road, air and waterway transportation system saved a lot of time over what it used to be.
III. Health care system: modern health care system based on scientific diagnosis and management has brought many diseases under control, thus improving tremendously on man's life expectancy. Diseases are no longer considered as punishment from evil spirits, but events to be studied and tackled accordingly.
IV. Communication: The 'Aroko' of yesteryears has given way to telephones and even today wireless phones of different generations are carrying not just human speech but also data and video information.
V. Energy: modern electric energy has been generated from all forms of sources such as fossil fuels, wind, water, thermal, nuclear, solar and others
VI. Manufacturing/Industry: High technology driven and better product
VII. Water supplies: traditional river, well, spring to hygienic well treated public water systems

3.6 Ethics

Although the advantages of technology outweigh the disadvantages, the negative side of technology must be discussed. Especially the level of insecurity of the life occasioned by extensive development and deployment of weapons and other instruments of destruction.

Atmospheric pollution and environmental degradation occasioned by deployment of high technology in the exploitation of earth resources
The millions of men who are being sent to their early grave through psychological traumas occasioned by loss of jobs to machines
The intellectual redundancy of man who are reduced to machine operators from the state of being active thinkers
Destruction of natural habitat through urbanization and urban culture, fast life, dishonesty, commercialisation of everything

3.7 Role of Science and Technology in Developing World

Any country in the world today that wants a robust economy, improved health system, good education and infrastructure must invest strongly in science and technology because they are the key drivers to development. Developing countries must also invest in quality education for youth and continuous skills training for workers and managers.

Technology revolutions of 21st century are machines produced to increase productivity at a large extent, to increase leisure time and to ensure things are down fast and smoothly,

Technology revolutions of 21st century include:

1. Microprocessors: Washing machines, Security alarms and systems, Remote control.
2. Telecommunications: Telephone network, Radio broadcasting system, Internet, Computer networks
3. Biotechnology: Fabrics, Plastics, Power and Heat systems
4. Artificial Intelligence: Robots
5. Nano-technologies,

4 Summary

In this unit, you have learnt that:

- Science is the totality of man's investigation about events in his environment and it separate the primitive man from modern man
- The stages of scientific methodology are: make an observation, ask a question, form a hypothesis, or testable explanation, make a prediction based on the hypothesis, test the prediction and iterate.
- The 21st century technology includes the microprocessor, artificial intelligence and so on

5.0 Self-Assessment Questions (SAQs)

i. write short note on role of science
ii. identify 3 positive effects of technology on man
iii. List 3 examples of 21st century technology

6.0 Tutor Marked Assessment

i. list with examples, the categories of activities branded as science
ii. Explain how technology has developed man
iii. Discuss the side effects of technology to man and his environment

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Module Fourteen

CONCEPTS OF HYPOTHESIS TESTING IN SCIENCES, SOCIAL SCIENCES AND HUMANITIES

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INTRODUCTION

In many real life situations, researchers often hypothesized about the relationship between several factors, collect some information (data) to examine the perceived relationship, and draw some inference based on the results of their investigations. Thus, the prime interest is to examine the strength of information obtained from samples as a basis for making a judgment about the generality of individuals or units (population) from where the samples are taken. This is the general basis of hypothesis testing. Hypothesis testing therefore is the process of understanding how reliable one can generalize the observed results in a sample under study to the larger population from which the sample is drawn.

The importance of statistical hypothesis tests in science, social sciences and humanities cannot be over emphasized. Lack of access to the entire population of units under investigation is a major factor that makes dependable inference about the population from sample inevitable.

Learning Outcomes

By the end of this module, you should be able to:

(i) define statistical hypothesis testing;
(ii) what are the basic steps in statistical hypothesis testing?;
(iii) distinguish between null and alternative hypotheses;
(iv) discuss the misconceptions in statistical hypothesis test; and
(v) In an engineering experiment as reported by Hsu et al. (2002), 45 steel balls lubricated with purified paraffin were subjected to a 40 kg load at 600 rpm for 60 minutes. The average wear, measured by the reduction in diameter, was 673.2 μm, and the standard deviation was 14.9 μm. Assume that the specification for a lubricant is that the mean wear be less than 675 μm, is it sufficient to conclude that this specification was met based on the 45 sample data drawn from lubrication experiment?

Main Body

Introduction

The module discuss the Concepts of Hypothesis Testing in Sciences, Social Sciences and Humanities under 3 units for easy teaching and learning to aid better understanding of the

subject. These units are:

Unit 1 Importance of Statistical Hypothesis Testing
Unit 2 Basic Steps in Statistical Hypothesis Testing
Unit 3 Classical Example

UNIT 1: IMPORTANCE OF STATISTICAL HYPOTHESIS TESTING

Contents

1.0 Introduction

The units expand on the importance of Statistical hypothesis testing, enumerating the null and alternative hypothesis and explain the type of error.

2.0 Learning Outcomes

By the end of this unit, you should be able to:

(i) define statistical hypothesis testing;
(ii) Explain the null and alternative Hypotheses; and
(iii) Describe with 2 examples types I and II errors and power of a statistical Hypotheses Test

3.0 Main Content

3.1 The Importance of Statistical Hypothesis Test

The importance of statistical hypothesis test in science, social science and humanities research cannot be overemphasized. Firstly, a statistical hypothesis helps to determine the focus and direction for a research effort. By developing a good statistical hypothesis the researcher would be able to state clearly, the purpose of the research activities. Another importance is that a good statistical hypothesis helps to determine what type of variables to be considered or not to be considered in a study. This would enable the researcher to have an operational definition of the variable of interest in his/her research.

3.2 The Null and Alternative Hypotheses

As would be discussed later, one of the basic steps in statistical hypothesis testing is the transformation of the research question into null and alternative hypotheses (*Browner et al. 2001*). The null hypothesis, usually denoted by H_0 is a competing hypothesis that negates or contradicts the research hypothesis which is the alternative hypothesis that is usually denoted by H_1. The research's hypothesis H_1 is the hypothesis of interest that the investigator wants to ascertain its veracity base on empirical evidence from the sample data. The null hypothesis on the other hand is the hypothesis of no effect which is basically the opposite of the research hypothesis.

In a general term, the null and alternative hypotheses are two concise statements, usually in mathematical form, of possible versions of "truth" about the relationship between the predictor of interest (empirical evidence from sample) and the outcome in the population (Davis and Mukamal, 2006). These two statements must be mutually exclusive (non-overlapping) and exhaustive by covering all the possible truths concerning the characteristics of interest under study. For example, the research hypothesis (H_1) could be of the following forms:

i) H_1: "The average performance of students in a CBT GNS examination is different from their average performance in an MBT GNS examination"
ii) H_1: "The average performance of students in a CBT GNS examination is better than their average performance in an MBT GNS examination"
iii) H_1: "The average performance of students in a CBT GNS examination is worse than their average performance in an MBT GNS examination"

The first research hypothesis in (i) only indicates a bidirectional type of the effect of interest. If a test results uphold H_1, this would only indicate that the average performance of students under the two test types are not the same without indicating which of them is better. This is called a two-tail (2-tail) alternative hypothesis set. If the Greek symbols μ_{CBT} and μ_{MBT} are used to indicate the average performance of the students in CBT and MBT examinations in that course respectively, the conventional form for stating H_1 would be H_1: $\mu_{CBT} \neq \mu_{MBT}$
The second and third research hypotheses in (ii) and (iii) are one directional in that they both indicated the direction of the effect of interest. They are both referred to as one-tail (1-tail) hypothesis set with hypothesis (ii) being right-sided and hypothesis (iii) being left-sided. Also, the two research hypotheses (ii) and (iii) can be conventionally written as H_1: $\mu_{CBT} > \mu_{MBT}$ and H_1: $\mu_{CBT} < \mu_{MBT}$ respectively.

The corresponding null hypothesis (H_0) for each research hypothesis set H_1 stated in (i) to (iii) above are given as follow:

i) H_0: "The average performance of students in a CBT GNS examination is not different from their average performance in an MBT GNS examination"
ii) H_0: "The average performance of students in a CBT GNS examination is not better than their average performance in an MBT GNS examination"
iii) H_0: "The average performance of students in a CBT GNS examination is not worse

than their average performance in an MBT GNS examination"
iv) The three null hypotheses above negate their respective alternative hypotheses sets H_1 as earlier stated. These hypotheses can be written in the short forms as H_0: $\mu_{CBT} = \mu_{MBT}$, for null hypothesis (I), H_0: $\mu_{CBT} \leq \mu_{MBT}$ (conventionally stated as H_0: $\mu_{CBT} = \mu_{MBT}$) for null hypothesis (ii) and H_0: $\mu_{CBT} \geq \mu_{MBT}$ (conventionally stated as H_0: $\mu_{CBT} = \mu_{MBT}$) for null hypothesis (iii).

If both the null and alternative hypotheses above are stacked together, we have their respective complete statistical representations as follows:

I) H_0: $\mu_{CBT} = \mu_{MBT}$ versus H_1: $\mu_{CBT} \neq \mu_{MBT}$ (Two-tail hypothesis test)
ii) H_0: $\mu_{CBT} = \mu_{MBT}$ versus H_1: $\mu_{CBT} > \mu_{MBT}$ (One-tail hypothesis test, right sided)
iii) H_0: $\mu_{CBT} = \mu_{MBT}$ versus H_1: $\mu_{CBT} < \mu_{MBT}$ (One-tail hypothesis test, left sided)

When a statistical test rejects the null hypothesis H_0 in favour of the alternative set H_1, the test result is said to be significant (Huberty 1994, Royall 1997).

In summary, the null hypothesis is conventionally used to describe a lack of association between numerical evidence from sample and the outcome in the population, whereas, the alternative hypothesis describes the existence of an association which is what the investigator typically wants to establish. The goal of statistical hypothesis testing therefore is to decide whether there is sufficient evidence from the sample under study to conclude that the alternative hypothesis should be believed.

It is important to remark that if the null hypothesis H_0 is not rejected in any of the one-tail hypotheses tests for a given data set, this does not necessarily implies that the two population means μ_1 and μ_2 being compared are the same, especially when H_0 is rejected under the two-tail hypothesis for the same data set. Failure to reject H_0 under such one-directional alternative sets simply suggests that the stated order of differences in means ($\mu_1 > \mu_2$ or $\mu_1 < \mu_2$ in the alternative H_1 is not supported by the data but not that $\mu_1 = \mu_2$

3.3 Type I and Type II Errors and Power of a Statistical Hypothesis Test

When statistical hypothesis is being tested, two types of errors are likely to be committed. These are referred to as Type I and Type II errors in statistics (Ware et al. 1992; Quinn and Keough 2002; Adeleke 2002). The concepts of Type I and Type II errors were originally provided by Jerzy Neyman and Egon Pearson (Neyman and Pearson 1928).

The **Type I error** (Lind et al. 2004) is the error committed when a correct null hypothesis is wrongly rejected. This is usually being measured in quantitative term by the Greek letter α that is defined as the probability of wrongly rejecting a correct null hypothesis. Since α is a probability, its values range between 0 and 1. Conversely, the probability of taking a correct decision by accepting a true null hypothesis is given by 1- α. Explaining this differently, the probability of committing Type I error α is often call the *level of significance* of a statistical

hypothesis test whose value is usually chosen prior to the commencement of the test. The value of α chosen by an investigator indicates how much he/she wants to risk committing a Type I error. Fisher (1935) earlier recommended 5% for value of α which indicates 1 in 20 chance of false rejection of the correct null hypothesis. Fisher (1956) thereafter argued that a fixed value of 5 % for α should be chosen depending on the situation being investigated. However, it should be noted that the closer the chosen value of α is to zero the smaller the chance of committing Type I error in a significance test problem. In many social science researches, the levels of significance commonly used are 5 %, 1 % and 0.1 % which simply translates to 95 %, 99 % and 99.9 % correct acceptance of true null hypothesis respectively. In behavioral sciences, 5 % is a common choice for value of β and it represents the probability of wrongly accepting a false null hypothesis that should be rejected. The converse of this naturally translates to the power of a statistical significant test.

The power of a statistical test, denoted by 1-β, is the probability of correct rejection of a false null hypothesis (Quinn and Keough 2002). This is the probability of taking correct decision that is, rejecting H_0 when there is actually strong numerical evidence against it from the sample data. Putting this differently, the power of a statistical test is the ability of the test to detect the desired alternative hypothesis set when it is true. The concepts of Type I and Type II errors as well as power of statistical tests are presented in the confusion matrix given in Table 1.

		Decision based on sample	
		Reject H_0	**Accept H_0**
Truth about the population	**H_0 is true**	Type I error (??)	Correct decision (1-??)
	H_0 is false	Correct decision, Power (1 - ??)	Type II error (??)

Table 1: Confusion matrix showing Type I error, Type II error and the probabilities of taken correct decisions in statistical hypothesis test.

4.0 Summary

The unit discuss the statistical testing, showed basic steps in statistical hypothesis testing and explained the null and alternative hypothesis with illustrations.

5.0 Self-Assessment Questions (SAQs)

(i) define statistical hypothesis testing;
(ii) Explain the null and alternative Hypotheses; and
(iii) Describe with 2 examples types I and II errors and power of a statistical Hypotheses Test

6.0 Tutor Marked Assessment

Use table to present the confusion matrix showing Type I error, Type II error and the

probabilities of taken correct decisions in statistical hypothesis test .

7.0 Further Reading

Adeleke, B. L. (2002): *An Introduction to Statistics*. *Alfred Consult.* Nigeria.
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Davis, R. B. and Mukamal, K. J. (2006): **Hypothesis Testing: Means. *Circulation*,** 114:1078-1082. doi: 10.1161/circulationaha.105.586461
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UNIT 2 BASIC STEPS IN STATISTICAL HYPOTHESIS TESTING

1.0 Introduction

The unit discussed basic steps in statistical hypothesis testing and how to specify the null and alternative hypotheses.

2.0 Learning Outcomes

At the end of this unit, you should be able to:

i. define the basic logic of hypotheses testing?
ii. List the 5 steps that represent common feature to all steps proposed for carrying out statistical hypotheses test as reported by Fisher in 1956

3.0 Main Contents

3.1 The Basic Steps in Statistical Hypothesis Testing

The basic logic of hypothesis testing is to prove or disprove the research question as stated under the alternative hypothesis set H_1. The steps to be followed while performing a statistical hypothesis test are reported in various forms in the literature (Underwood 1997; Mulai *et al.* 1997; Davis and Mukamal 2006). A common feature to all the steps proposed for carrying out statistical hypothesis test requires formulation of hypothesis of interest to be tested and the usage of appropriate test statistics.

An adaptation of the basic steps required in classical hypothesis (significant) testing in statistics as proposed by Fisher (1954, 1956) and widely reported in the literature (Huberty 1993; Quinn and Keough 2002) are presented below, variants of which exist in many works.

i.) State the research question or problem.
ii.) Specify the null and alternative hypotheses.
iii.) Chose and calculate the test statistic.
iv.) Compute the p-value or the critical value of the test statistic and take a decision.
v.) Draw conclusion from the test's results.

Each of the above five steps is discussed in detail in what follows. However, since most of the hypothesis tests problems in sciences, social sciences and humanities often center on the comparison of population means, therefore, our subsequent discussions shall be focused to this direction.

State the Research Question or Problem

The first step in statistical hypothesis testing is to state the research problem in terms of a question that identifies the target population(s) of interest and their characteristics as well as the population(s) parameters to be tested. This step makes the researcher not only to define what is to be tested but what variable will be used in sample collection. The type of variables (categorical, discrete or continuous) involves in the study and their desirable probability distributions should be stated.

In a classical test on mean performance of students in a GNS course for example, the research question may be stated as "***Is the mean score of student in GNS 111 course equal to 60 %?***" Under this problem, the target population is all the students that wrote GNS 111 examinations, the variable of interest is continuous and it represents the scores obtained by all the students in that course. The parameter of interest is the mean score of all the students in the course with hypothesized value of 60. Any randomly selected scores (sample) drawn from the entire scores of students in that course should be distributed normal with a mean of 60 usually written as

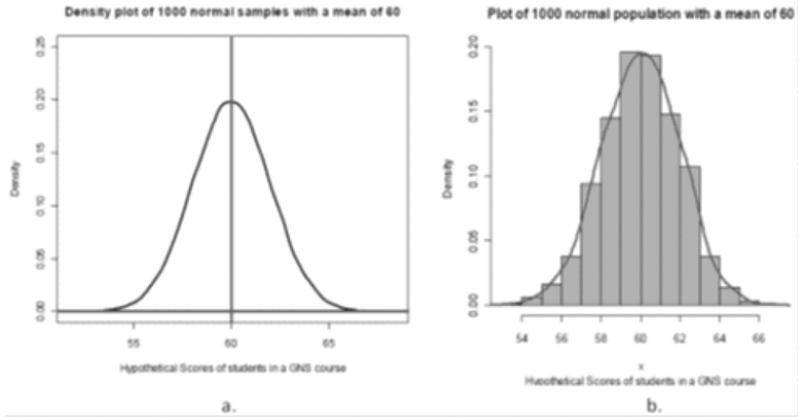

Table 1: Confusion matrix showing Type I error, Type II error and the probabilities of taken correct decisions in statistical hypothesis test.

4.0 Summary

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5.0 Self-Assessment Questions (SAQs)

(i) define statistical hypothesis testing;
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Use table to present the confusion matrix showing Type I error, Type II error and the probabilities of taken correct decisions in statistical hypothesis test .

7.0 Further Reading

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Fisher, R. A. (1935): *The Design of Experiments*. Oliver & Boyd, Edinburg

$$1 - p(Z \leq 2.08)$$

Fisher (1954): *Statistical Methods for Research Workers*. Oliver & Boyd, Edinburgh.
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Gigerenzer, G. (1993): *The Superego, the ego and the id in Statistical reasoning*. In: *A handbook for data analysis in behavioural Sciences-Methodology Issues.* (Keren, G. and Lewis, C. eds), Lawrence Erlbaum Associates, New Jersey.

UNIT 2 BASIC STEPS IN STATISTICAL HYPOTHESIS TESTING

1.0 Introduction

The unit discussed basic steps in statistical hypothesis testing and how to specify the null and alternative hypotheses.

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State the Research Question or Problem

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In a classical test on mean performance of students in a GNS course for example, the research question may be stated as "***Is the mean score of student in GNS 111 course equal to 60 %?***" Under this problem, the target population is all the students that wrote GNS 111 examinations, the variable of interest is continuous and it represents the scores obtained by all the students in that course. The parameter of interest is the mean score of all the students in the course with hypothesized value of 60. Any randomly selected scores (sample) drawn from the entire scores of students in that course should be distributed normal with a mean of 60 usually written as

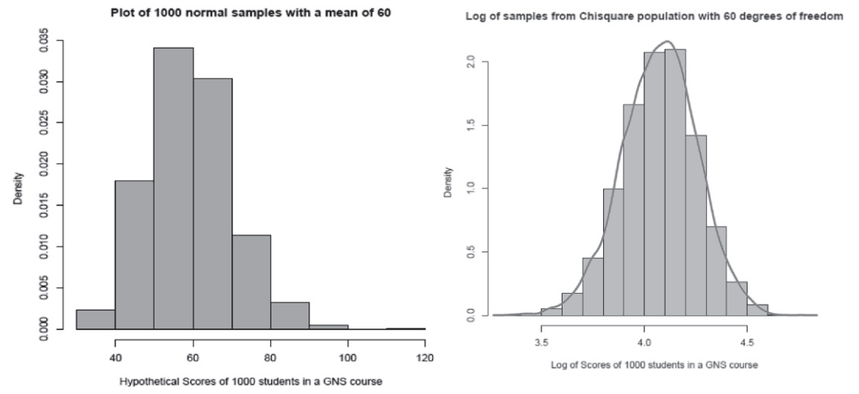

Fig 2: The histogram of 1000 chi-square random samples with 60 degrees of freedom (a) showing a right skewed distribution and the histogram the log transformed samples (b)

showing a bell-shape (normal) distribution.

The illustrations in Fig1 and Fig2 clearly underscore the need to usually examine the behaviour of sample data for their conformance to the required distributional assumption while carrying out statistical hypothesis tests. Any deviation from the assumed probability distribution may require little data transformation as demonstrated in Fig 2.

Apart from normality assumption, other assumption about the data that must be met at this stage is that of independent of random samples that are drawn from the population of interest. All these basic assumptions on the variable of interest must be met in order to guarantee efficient and reliable statistical hypothesis tests.

3.2 Specify the Null and Alternative Hypotheses

The second step in hypothesis testing is the formulation of both the null and the alternative hypothesis. The research question is stated as the alternative hypothesis H_1 while its negation would be the null hypothesis H_0 as given below using our illustrative example on students' performance in GNS111 examination.

H_0: The mean score of student in GNS 111 is 60 % (i.e. H_1:$\mu = 60$)
H_1: The mean score of student in GNS 111 is not 60 % (i.e. H_1:$\mu \neq 60$)
Any of the one-directional alternatives could also be of interest to the investigator. That is, H_1:

The mean score of student in GNS 111 is greater than 60% (i.e. H_1: $\mu > 60$) or H_1: The mean score of student in GNS 111 less than 60 % (i.e. H_1: $\mu < 60$ as in our example here, then the appropriate test statistics should be a function of the sample mean μ as in our example here, then the appropriate test statistics should be a function of the sample mean $\bar{x}$ (xbar) and possibly the sample standard deviation (s) if the population standard deviation $Z = \frac{X-\mu}{s.e.(\bar{X})}$

The statistics Z has a normal distribution with zero mean and a unit standard deviation usually written as $Z \sim N(0,1)$. The standard error of sample mean ($s.e.(\bar{X})$) is $\frac{\sigma}{\sqrt{n}}$ where$n$ The sample standard deviation s is often used in place of its populatıon value $\bar{X}$ The sample standard deviation s is often used in place of its population value $n-1$ degrees of freedom, often written as $t \sim t_{n-1}$ with Z being replaced by t in the above test statistic Z
As a general remark, if the value of σ is estimated by s from large samples of size n(e.g. $n > 120$), the distribution of the test statistic Z or t would essentially be standard normal. This shows that the same conclusions would be made using the Z or t statistic under the large sample situations.
In our earlier null hypothesis H_0: $\mu = 60$ against the two-sided alternative H_1: $\mu \neq 60$

$$\hat{Z} = \sqrt{25}\frac{(62.5-60)}{6} = 2.08$$

Compute the p-value or the Critical Value of the Test Statistic and take a decision

The fourth step in hypothesis testing is the computation of the p-value or the critical value of the test statistic computed in step three. The decision of the test results will be based on either of these two values. Interestingly, many researchers are more familiar with the use of critical values than the p-values in significant tests. The applications of the two values are presented here.

The p-value of a statistical test here denoted by p_v is the probability of obtaining the value of the test statistic or more extreme value when H_0 is true (Quin and Keough 2002; Davis and Mukamal 2006). For a test statistic $p(Z > \hat{Z}) = 1 - p(Z \leq \hat{Z})$ the $p(Z \leq \hat{Z})$ is the cumulative density function (cdf) of the standard normal distribution whose value can be easily read from any statistical table or computed using statistical package.
To use the p-value for inference purposes, the investigator must have chosen a particular level of significance α for the test against which the computed p-value would be compared. For a two-sided alternative hypothesis test, the decision rule is to reject the null hypothesis H_0 in favour of the alternative set H_1 if the $2p_v$ (2 x p-value) is less than the chosen significance level α. For one tail alternative test, the rule is to reject H_0 if p_v is less than α. However, when the null hypothesis is rejected, the outcome is said to be "statistically significant" and when it is not rejected then the outcome is said to be "not statistically significant".
In our example, the value of the test statistic $\hat{Z}$ is 2.08 and its p-value is $1 - p(Z \leq 2.08)$ which is 0.0188 (i.e. 1-0.9812). The value 0.9812 of $p(Z \leq 2.08)$ is computed using R statistical package (www.cran.org) and can be easily read as well from any statistical table.
With a p-value (p_v) of 0.0188, $2p_v$ = 0.0376 and the null hypothesis H_0 that the mean performance of students in GNS111 is 60% (H_0: $\mu = 60$) is rejected in favour of the alternative hypothesis that the student performance is not 60% (H_1: $\mu \neq 60$) at 5% significance level since 0.0376 is less than 0.05. Hence, the test is statistically significant. However, if 1% significance level is intended by the investigator here, the null hypothesis would not be rejected since $p_v > 0.01$.
If the sample standard deviation s(= 6) is used in the computation of the value of the test statistic Z the distribution of Z becomes a student t distribution with 24 degrees of freedom. Here, the p-value is $1 - p(t \leq 2.08)$ at 24 degrees of freedom which is 0.0242. With $2p_v$ = 0.0484, the null hypothesis would be rejected as before at 5% level of significance.
The critical value of the test statistic is another tool by which a decision can be made on the significant tests based on sample data. The critical value C_α of a statistical test is the quantile value obtained from the distribution of the test statistic at size C_α is a threshold value against which the estimated value of the test statistic would be compared in order to form a decision as to whether the null hypothesis should be rejected (if the test statistic value is greater than C_α) or not being rejected (if the test statistic value is less than C_α).
In our earlier example, the Z statistic is distribute standard normal, therefore its critical value is the quantile value $Z_{1-\frac{\alpha}{2}}$ at significance level α The rule that would guide us to be able to decide whether to accept or reject the null hypothesis at any chosen α value which is usually

called the decision rule becomes that of rejecting the null hypothesis H_0 in favour of the alternative set H_1 if the inequality $|\hat{Z}| \geq Z_{1-\frac{\alpha}{2}}$ holds for two-sided alternative hypothesis set. For alternative hypothesis sets $H_1: \mu > 60$ or $H_1: \mu < 60$, the rule is to reject H_0 if $\hat{Z} \geq Z_{1-\alpha}$ or $\hat{Z} \leq -Z_{1-\alpha}$ respectively.

At 5% α level, the critical value $Z_{1-\frac{\alpha}{2}}$ is $Z_{0.975} = 1.96$ and with $\hat{Z} = 2.08$, the estimate of the test statistic, the decision is to reject the null hypothesis ($H_0: \mu = 60$) that the mean performance of students in GNS111 is 60% in favour of the alternative ($H_1: \mu \neq 60$) that the mean performance of students in GNS111 is not 60%.

For one directional alternative hypothesis $H_1: \mu > 60$ or $H_1: \mu < 60$, the critical value $Z_{1-\alpha}$ is $Z_{0.95} = 1.645$. For the alternative hypothesis $H_1: \mu > 60$ and with $\hat{Z} = 2.08$ the decision is to reject H_0 in favour of H_1 since $\hat{Z} = 2.08 > Z_{0.95} = 1.645$ For one directional alternative hypothesis $H_1: \mu < 60$, the estimate of the test statistic $\hat{Z} = 2.08$ is not less than $-Z_{0.95} = -1.645$ (the critical value), hence decision not to reject H_0 in favour of H_1 should be taken. However, the decision not to reject H_0 here does not imply that the mean performance of students is 60%. This test result only shows that the directional alternative stated under H_1 ($\mu < 60$) is not supported by the data and the two possibilities are either the mean performance is not significantly different from 60% ($\mu = 60$) or greater than 60% ($\mu > 60$) which is the case here as confirmed by the result of one directional hypothesis $H_1: \mu > 60$ presented earlier.

Generally, when testing the null hypothesis H_0 against any of the one directional alternative hypotheses H_1 in one sample or two samples significant tests, the acceptance of H_0 in either case must be revalidated through the results of the test of H_0 against the two sided alternative hypothesis H_1 in order to make a correct judgment on the population based on sampled data.

Draw conclusion from the test's results

The last step in significant test is to drawn necessary conclusion based on the results of the test as suggested in the previous steps.

In our example, the conclusion is that the average performance of students in GNS111 is actually more than 60% based on the sampled data.

1.0 Summary

In this unit, we identified the basic logic of hypotheses testing and steps that represent common features to all proposed for carrying out statistical hypotheses testing.

2.0 Self-Assessment Questions (SAQs)

i. define the basic logic of hypotheses testing?
ii. List the 5 steps that represent common feature to all steps proposed for carrying out statistical hypotheses test as reported by Fisher in 1956

3.0 Tutor Marked Assessment

i. Discuss the basic logic of hypotheses testing
ii. Write concise notes on steps proposed for carrying out statistical hypotheses test

4.0 Further Reading

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UNIT 3 CLASSICAL EXAMPLE

Contents

1.0 Introduction

Science describes the world in form of qualities and attributes that human beings can understand using familiar descriptors such as numbers, shapes, sizes, weights and ratios. In doing this, science thus perform different functions in our life. The method of science is only one of the methods of knowing that yields knowledge. Therefore, science is one kind of knowledge that human beings base decisions upon. Science is not everything thus characterized by a few shortcomings despite of its numerous advantages.

2.0 Learning Outcome

At the end of this unit, you should be able to:

i. discuss the misconceptions in statistical hypothesis test; and
ii. solve the following problem:

In an engineering experiment as reported by Hsu et al. (2002), 45 steel balls lubricated with purified paraffin were subjected to a 40 kg load at 600 rpm for 60 minutes. The average wear, measured by the reduction in diameter, was 673.2 μm, and the standard deviation was 14.9 μm. Assume that the specification for a lubricant is that the mean wear be less than 675 μm, is it sufficient to conclude that this specification was met based on the 45 sample data drawn from lubrication experiment?

3.0 Main Content

3.1 Classical Example

We consider a more classical example from the literature to illustrate the use of hypothesis testing in the field of Engineering.

Example:

In an engineering experiment as reported by Hsu et al. (2002), 45 steel balls lubricated with purified paraffin were subjected to a 40 kg load at 600 rpm for 60 minutes. The average wear, measured by the reduction in diameter, was 673.2 μm, and the standard deviation was 14.9 μm. Assume that the specification for a lubricant is that the mean wear be less than 675 μm, is it sufficient to conclude that this specification was met based on the 45 sample data drawn from lubrication experiment?

Solution:

Firstly, we transform the problem into statistical language by considering the 45 samples as a set of random samples $X_1, \ldots, X_{45}$ of wear diameters with a mean ($\bar{X}$) of 673.2 μm and standard deviation (s) of 14.9 μm.
Following the steps required in hypothesis testing as earlier discussed, the research question here is whether the lubricant has met the specification by reducing the mean wear diameter of all the steel balls below 675 μm or not.
Arising from the research question is the formulation of the null and alternative hypothesis to be tested as stated below:
H_0: The lubricant does not meet the specification (i.e. the mean wear diameter is not less than 675 μm) versus
H_1: The lubricant meets the specification (i.e. the mean wear diameter is less than 675 μm).
In statistical symbols, the hypotheses above can be simply stated as

$$H_0: \mu = 675 \text{ versus } H_1: \mu < 675.$$

The null hypothesis H_0 above is simply suggestive of the fact that the apparent difference between the sample mean of 673.2 and 675 is just due to chance unless this is proved otherwise by a test's results.
The appropriate test statistic for the hypothesis is the t statistic given by $t = \frac{\sqrt{n}(\bar{x}-\mu_0)}{s} \sim t_{n-1}$

which has a student t distribution with $n-1$ degrees of freedom (df). The decision rule for this test problem is to reject H_0 if $\hat{t} < -t_{n-1,1-\alpha}$ or $p(t > \hat{t}) \leq \alpha$ (any intended significance level)
where $\hat{t}$ is the estimate of the test statistic $\hat{t}$, $t_{n-1,1-\alpha}$ is the critical value of the $\hat{t}$-distribution at significance level α with $n-1$ df. Also $p(t > \hat{t}) = 1 - p(t \leq \hat{t})$ is the p-value of the test statistic $\hat{t}$ at $n-1$ df.
To compute the test statistic, we already have from the sample information provided, that $\bar{X} = 673.2$, $s = 14.9$ and $n = 45$, the sample size. Also, the hypothesize parameter value is $\mu_0 = 675$. Therefore, the estimate of the test statistic t is

$$\hat{t} = \frac{\sqrt{45}(673.2 - 675)}{14.9} = -0.81$$

At 5% level of significance, the critical value $t_{44,0.95}$ for the test is 1.68 with 44 degrees of freedom (df). Based on this critical value, it may be difficult to reject the null hypothesis H_0 based on the available sample data since $-0.81 \not< -1.68$. Hence, it cannot be concluded that the lubricant meets the required specification (i.e. accepting H_1) given the data.

The above result does not mean that the null hypothesis H_0 is true, but it only shows that H_0 is plausible. By being plausible, we mean that if more sample data are collected on the problem being investigated the conclusion might no longer be in favour of H_0.

Using the p-value concept, the value of $p(t > -0.81)$ at 44 df is 0.79. Here, the p-value of 0.79 is interpreted to mean that if H_0 is true, there is 79% chance of observing a value of the test statistic (or sample mean) whose disagreement with H_0 is as least as great as that which was actually observed. Since this probability is large, we do not reject H_0 as before and conclude that the lubricant did not meet the required specification given the available sample data analysed.

3.2 Some Misconceptions in Statistical Hypothesis Test

In this section, we present a catalogue of some statistical concepts that are often misuse or misinterpret in significant hypothesis testing.
It is wrong to think that the p-value is the probability that the null hypothesis is correct. The p-value is the probability of the obtaining the current value of the test statistic or value that is more extreme assuming that the null hypothesis H_0 is true. The smaller the p-value of a test statistic, the stronger the evidence in support of rejection of H_0.

a) Failure to reject the null hypothesis H_0 does not imply that H_0 is correct. Such a test result only shows that there is no sufficient evidence in the current data that could have led to the rejection of H_0.
b) It is not correct to believe that 5 % level of significance (α) is a standard for all tests. The choice of α value should depend on the problem under investigation. If α value of 5 % seems reasonable for a particular test problem, it may be too bad a choice in some

others especially in drug discovery and studies.

c) It is wrong to believe that small p-value is an indication of large effect size. The two p-values of 0.01 and 0.0001 both suggested strong evidence to reject the null hypothesis but never an indication that the effect size in the former is smaller than the latter.

d) It is not correct to believe that statistical significance or non-significance implies the importance or non-importance of the relation being investigated. In other words, statistical significance does not necessarily mean biological significance in a biological investigation (Quinn and Keough 2002). Small effects that might not be statistically significant might be biologically significant most especially in genetic studies where small changes in some physiological measurements could result to serious biological impact.

4.0 Summary

The unit was able to teach to the students different misconceptions around the statistical hypotheses test and solve classical examples.

5.0 Self-Assessment Questions (SAQs)

i. Discuss 5 misconceptions in Statistical Hypothesis Test; and
ii. solve the following problem:

In an engineering experiment as reported by Hsu et al. (2002), 45 steel balls lubricatedwith purified paraffin were subjected to a 40 kg load at 600 rpm for 60 minutes. The average wear, measured by the reduction in diameter, was 673.2 μm, and the standard deviation was 14.9 μm. Assume that the specification for a lubricant is that the mean wear be less than 675 μm, is it sufficient to conclude that this specification was met based on the 45 sample data drawn from lubrication experiment?

6.0 Tutor Marked Assessment

Write concise not on misconceptions in Statistical Hypotheses test

7.0 Further Reading

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Module Fifteen

MICROBES AND DISEASES

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INTRODUCTION

Microbe is a noun coined from micro-organism, i.e. organisms that cannot be seen with the naked eye. They exist as single cells or cell clusters and can be appreciated with the aid of special gadgets such as the microscope. They form a very large and diverse group of organism that combines plant and animal features. They include bacteria, fungi, viruses and protozooans.

Microbes play very important roles in nature than their small size suggest. They form a significant integral part of the community that ensure interaction between living and non-living components and hence the sustenance of all ecosystems. They ensure the synthesis and degradation of special organic substances in the course of their existence. Man has over the years taken advantage of this in a number of ways such as the production of beer, yogurt and antibiotics, baking, soak away system, etc.

Learning Outcomes

By the end of this module, you should be able to:

(i) give the definition and various groups of microorganisms;
(ii) identify various microbial reservoir;
(iii) explain ways by which microbes can invade a susceptible host;
(iv) differentiate between pathogenicity and normal human flora;
(v) establish ways or routes of transmission of microbes; and
(vi) analyse the etiology and prevention of various microbial diseases

Main Body

Introduction

This module introduces you to meaning of Microorganism, Host Invasion, Pathogenicity, Reservoirs, Transmission and Microbial Diseases. This will be discussed under 2 units.

Unit 1 Microorganisms
- Subunit 1 Host Invasion
- Subunit 2 Pathogenicity
- Subunit 3 Reservoirs

Unit 2 Microorganisms
- Subunit 2 Transmission
- Subunit 3 Microbial Diseases

UNIT 1: MICROORGANISMS

Contents

1.0 Introduction

This unit introduces Host Invasion and pathogenicity.

2.0 Learning Outcomes

By the end of this unit, you should be able to:

(i) define and various groups of microorganisms;
(ii) explain ways by which microbes can invade a susceptible host;
(iii) Reservoirs; and
(iv) differentiate between pathogenicity and normal human flora

3.0 Main Content

3.1 Host Invasion

Microbes play very important roles in nature than their small size suggest. They form a significant integral part of the community that ensure interaction between living and non-living components and hence the sustenance of all ecosystems. They ensure the synthesis and degradation of special organic substances in the course of their existence. Man has over the years taken advantage of this in a number of ways such as the production of beer, yogurt and antibiotics, baking, soak away system, etc.

Human microflora occur on the skin, orifices, i.e. mouth, nose, anus, vagina etc; body fluids such as saliva, blood, semen etc., as well as, in the tissues. Most of these form normal body microflora, in which case their presence is not harmful to their host. The detrimental or pathogenic forms, however, elicit disease condition i.e. an alteration in the host system resulting in the loss of productivity, in man as a result of the interaction with the microbe. This disease possibility necessitates a discussion on Microbes and Diseases, believing that a thorough understanding of the etiology of microbial disease of man will reduce their incidence and therefore enhance human livelihood.
To elicit disease condition, microbes must establish contact, multiply and colonise its host

either superficially or in the tissue. To achieve this, they require to have conquered the series of defence mechanisms put up by an unwilling host. The most prominent of this is the impenetrable skin that serves as barrier. The determined microbes, however, make their way in by adhering to the surface and producing chemical substances (enzymes) that break the barrier for them. Some of them take advantage of skin lacerations by way of wounds, while others reside in obscured spaces with restricted access but clement environment such as the mouth, anus and vagina. Microbes are known to show preferences for site of occurrence. e.g. *Nisseria gonorrhea*, a microbe causing sexually transmitted disease known as Gonorrhea. which sticks strongly to the inner lining of the urinogenital tract than any other place.

3.2 Pathogenicity

Microbes initiate some level of alterations in the host's system as a result of their activities. Some of these activities are aimed at improving their survival chances in the areas of food acquisition and avoidance of the host's defense actions. Some of these activities include:

- Production of excretory wastes that may be intolerable to the host and hence referred to as toxins
- Deprivation of the host of its nutrients
- Confiscation of host tissue for personal use by the microbe. e.g. viral infections
- Destruction of the host tissue, e.g. anemia resulting from malaria infection
- Initiation of tissue changes that may lead to cancers or tumors and
- Reduction of host immune response thereby giving room for opportunistic infections.

3.3 Reservoirs

Microbes reside temporarily in one or more natural environments known as reservoirs. The major reservoirs are water, soil, atmosphere, humans, domestic and wild animals. In their bid to survive they move from one reservoir to the other and become successful when established in their host. Diseases that are contractible by humans from other animals are termed zoonotic diseases.

4.0 Summary

The unit drive the discussed on Host invasion, Pathogenicity and reservoirs.

5.0 Self-Assessment Questions (SAQs)

(i) give the definition and various groups of microorganisms;
(ii) explain ways by which microbes can invade a susceptible host;
(iii) reservoirs; and
(iv) differentiate between pathogenicity and normal human flora

6.0 Tutor Marked Assessment

Write concise notes on:

i. Host invasion

ii. Pathogenicity
iii. Reservoirs

7.0 Further Reading

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UNIT 2 MICROORGANISMS AND MICROBIAL DISEASES

Contents

1.0 Introduction

This unit will further discuss microorganisms and its transmission and the kinds of diseases that can result as a means of that.

2.0 Learning Outcomes

By the end of this unit, you should be able to:
(i) establish ways or routes of transmission of microbes; and
(ii) analyse the etiology and prevention of various microbial diseases

3.0 Main Contents

3.1 Transmission

The essence of successful transmission bid is to ensure the establishment of the offspring or progenies of a particular microbe in another host of the same kind; a mission that entails movement across reservoirs. They, therefore, utilize media that are inevitably used by their prospective host such as air, water, food, etc... The following four basic ways are often employed:

- **Contaminated food and water (Oral-faecal route)**

Ingestion of contaminated food and water is a popular mode of microbial transmission.

Faecal contamination is usually the source of such pathogens, as they reside mostly in the alimentary canal and they are voided out via the anus. They gain access to drinking water or food owing to inadequate sanitary procedures or sometimes directly when one licks unclean hands after visiting the toilet.

- **Contamination of the respiratory tract (Respiratory route)**

Pathogenic microbes may find their way to the host's respiratory tract, irritate the host and force it to sneeze or cough. These activities, as well as, talking and throwing out sputum are primarily meant to protect the unwilling host, but they aid the transference of the microbes to other hosts in form of droplets in the atmosphere. The pathogens are successfully transmitted when a prospective host inhales such droplet. Most of the pathogens remain active and infective even after the droplet had dried up and they could be transported by wind.

- **Direct contact with infected persons, animals or contaminated objects**

Pathogens frequently utilize the opportunity of contact to get across to a new host. Such a pathogen is described as-a contagion. Such contacts may be direct or indirect, e.g. sexual intercourse, kissing, sharing of toiletries, renting of dresses, etc. The entry may be via open wound, e.g. Tetanus bacteria from soil.

- **Inoculation through the skin**

Pathogens may take advantage of the interaction between blood sucking parasite of man and man. The microbe makes itself available to the vector when it feeds on human blood. It is then transmitted to another host while consuming blood from its new host. Such pathogens usually grow and multiply in the vector. e.g. Plasmodium and Anopheles mosquito.

3.2 Microbial Diseases

Microbes and the diseases initiated by them are numerous; however, some of the examples of these diseases shall be reviewed with emphasis on those that are of common occurrence in Nigeria. The diseases have been grouped on the basis of their causative agent into bacterial fungal, viral and protozoan diseases. The name, location in the host, mode of transmission, part of the host body affected, clinical manifestation, treatment and prevention of each disease are described briefly.

Viral diseases: These are caused by the smallest organism described, i.e. virus. They can not be seen under the common light microscope. They are obligate parasites that show evidence of living only when in their host. Outside their host they are inert; hence they me regarded as organisms at the borderline between living and non-living things. Viruses usually occur, live and multiply within the cell of its host and they take over the control of such cells from their respective nuclei and from the host. Thus one of the general characteristics of viruses is their ability to alter the working method or system of the cells of a host. Table 1 shows a summary of the etiology of six common viral diseases and possible treatments and preventive measures. Viral diseases are usually difficult to treat owing to the fact that they reside within the host's cell where drugs cannot be tolerated. An effective drug at this point may kill the host cell before the virus. More emphasis is, therefore, placed on prevention, which ensures that the pathogens do not find their way into the host cell. When they do, however, the microbe is usually left for the host's immune system to handle.

Table 1: Etiology, treatment and prevention of some viral diseases of man

Disease Type	Causative agent	Clinical manifestation	Part of body affected	Method of spread	Prevention and treatment
Polio	picorna virus	Headache, fever, Paralysis	Intestine and nervous system	Droplet infection, feacal contamination	Vaccination, boil water for all purpose
Measles	Paramyxo virus	Fever, nose and eye discharge, rashes, coughing, death	Skin and Intestine	Droplet infection	Isolation of patients, avoiding overcrowding, improving ventilation, vaccination
Yellow fever	Arbovirus	Fever, headache, yellow eyes	Blood, liver, kidney	Mosquito vectors	Vaccination, avoiding mosquito bite
Smallpox	Venola virus	High fever, skin blister and rashes, death	Respiratory tract, blood, skin	Droplet infection, wound contagion	Vaccination, improved ventilation, avoiding overcrowding, patient isolation
Common cold (catarrh)	Rhinovirus	Running nose, headache, sneezing	Respiratory tract	Droplet infection	Patient isolation, improved ventilation avoiding overcerowding
AIDS	HIV (Human Immuno-deficiency virus)	Inability to defend self against other disease	The immune system	Contagion in body fluid	Controlled sexual activity, avoidance of body fluid contact

Bacterial Diseases: Several human diseases are caused by bacteria of various types. Bacteria are among the smallest living organisms. They are the first group of micro-organisms to be discovered as a disease causing organism. Most of them gain entry into their host via the mouth, nose, vagina, anus or lacerated skin. They obtain their food from their host by secreting enzymes that break down food substances to simpler forms that are readily absorbed by them. They also secrete waste products that are usually toxic to their host. Table 2 gives specific information on the etiology, clinical manifestation, treatment and prevention of some common bacterial diseases of man.

Table 2: Etiology, treatment and prevention of some bacterial diseases of man

Disease Type	Causative agent	Clinical manifestation	Part of body affected	Method of spread	Prevention and treatment
Cholera	Vibrio cholorae	Gut irritation, severe diarrhea, deg=hydration, death	Alimentary canal	Faecal contaminated food and water, vectors (housefly)	Provision of good water, good personal hygiene. Use of antibiotics ORT
Leprosy	Bacillus sp	Loss of sensation, sore on skin, loss of flesh and bone	Skin and nervous system	Droplet infection, prolonged close contact	Isolation of infected individuals, feeding well, use of drugs
Tuberculosis	Mycobacterium tuberculosis	Irritation of the respiratory tract, coughing	Lungs	Droplet infection, milk sourced from infected cattle	Feeding well, Vaccination, (BCG) use of antibiotics
Pneumonia	Pneumococcus sp	Chest pain, high fever, constant coughing	Lungs and respiratory tract	Droplet infection	Isolation of infected individuals, avoid overcrowding, use of antibiotics
Gonorrhea	Neisseria gonourrhoeve	Difficulty in urinating in men, sterility in both sexes	Reproductive organ, eyes of infants	Contagion by sexual contact	Restricted intercourse, avoiding contact with infected body fluid, use of antibiotics
Syphilis	Treponema poludium	Mental impairment, skin blisters, brain damage	Reproductive organ, eyes bones, joints, skin and heart	Contagion by sexual contact	Restricted intercourse, avoiding contact with infected body fluid, use of antibiotics
Tetanus	Clostridum tetanus	Lockjam spasm	Blood nerves and muscles	Wound contamination	Improved personal hygiene, putting iodine on fresh wounded surface

Fungal Diseases: Disease causing fungi in man are few. *Trichophyton sp* causes 'ringworm' and 'athletes foot' diseases in children and adults, respectively. This fungus obtains its nourishment from the outer layer of the skin with the aid of root-like structures called hyphae. It gives a small dark or red patch that grows, but becomes restricted to the outer margin of a portion with restored skin colouration and without hair strands later, hence the name 'ringworm'. These patches frequently occur on the scalp, inside the thighs and armpits. On the scalp, it gives a scaly bald patch without hair strands. Fungal disease spreads by personal or indirect contact achieved by way of sharing clothing and other personal effects such as sponge, comb, socks etc. The best preventive measure is to ensure personal cleanliness and discourage the use of damp socks and cover shoes. They are frequently treated with antiseptic devices.

Protozoan diseases: Protozoans are tiny single celled organisms. Most of them are free living. A few of them, e.g. *Plasmodium* sp are however parasitic and they cause malaria and trypanosomiasis (sleeping sickness), respectively in man.

Malaria is caused by *Plasmodium* sp, a pathogen that resides in the blood of man. They colonize the red blood cell, feed within it, reproduce in it and break it open, thus destroying it. This destruction results in anaemia. The pathogens also produce toxins that initiate rigors associated with malaria fever. The pathogens gain access into human blood stream through the feeding action of female Anopheles mosquito, which acts as a vector. The mosquito collects the pathogen from an infected individual while sourcing for blood, develops the pathogen to an infective form and subsequently passes the infective pathogen to a healthy individual during blood sucking activity. The symptoms of the disease include fever, i.e. high body temperature, headache, pains especially at the joints, little and deeply coloured urine, etc. Due to the high level of debility involved, chronic sufferers are usually incapable of carrying out their daily chores and so it leads to significant economic losses. Prevention is only achievable by avoiding contact with mosquitoes. Taking drugs to prevent malaria lead to undesirable effects such as the development of resistant to Plasmodium strain that will not respond to the common antimalarial drugs, thus complicating the management of malaria. Treatment is readily achieved through the use of drugs.

Trypanosomiasis: *Trypanosoma* resides in the blood stream of man where they obtain their food and reproduce. They produce toxin which makes the host sick. The microbes are transmitted from one human host to the other by Tsetse fly (Glossina sp) while prospecting for blood. Signs and symptoms of the disease include fever, emaciation, sleeping almost always and eventually death. Prevention involves avoidance of tsetse fly and treatment entails the use of drugs.

1.0 Summary

Transmission is discussed and microbial diseases. The diseases have been grouped on the basis of their causative agent into bacterial fungal, viral and protozoan diseases. The name, location in the host, mode of transmission, part of the host body affected, clinical manifestation, treatment and prevention of each disease are described briefly.

2.0 Self-Assessment Questions (SAQs)

(i) establish ways or routes of transmission of microbes; and
(ii) analyse the etiology and prevention of various microbial diseases

3.0 Tutor Marked Assessment

i. Group the diseases on basis of their causative agent, listing the name, location in the host, mode of transmission, part of the host body affected, clinical manifestation, treatment and prevention of each disease.
ii. Analyse the etiology and prevention of various microbial diseases

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Module Sixteen

GEOMOPHOLOGY OF AFRICA

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INTRODUCTION

The physical environment of an area is as important as the people living within it. It contains features which are products of natural and/or artificial activities. Such features include hills, valleys and plain surfaces. They present beautiful landscapes and in places, are tourist centres (e.g Zuma rock in Nigeria). Almost every state in Nigeria and countries in Africa has its peculiarity in terms of landscape. Therefore, it is important as students and citizen of Africa to know, not only variations in characteristics of landscapes from region to region but understand the origin of the elements (mountain, valleys and river systems) of those landscapes in our physical environment.

Learning Outcomes

By the end of this module, you should be able to:
(i) explain the concept of Geomorphology
(ii) discuss factors which are responsible for geomorphological variations –volcanism, weathering, erosion, landslide;
(iii) explain reason for geomorphological variations in Africa countries;
(iv) describe important physical features in Africa, especially Nigeria; and
(v) explain morphological characteristics of the ocean floor.

Main Body

Introduction

The Module discuss about the physical environment features that involves artificial and natural activities such as hills, valleys and plain surfaces looking into different peculiarities in African countries. This will be looked into via 2 units.

UNIT 1: GEOMORPHOLOGY

Contents

1.0 Introduction

The unit will discuss what geomorphology is with examples and then dwell into its variations.

2.0 Learning Outcomes

By the end of this unit, you should be able to:

(i) explain the concept of Geomorphology
(ii) discuss factors which are responsible for geomorphological variations –volcanism, weathering, erosion and landslide; and
(iii) explain reason for geomorphological variations in Africa countries

3.0 Main Content

3.1 Geomorphology

Geomorphology is 'coined' from two words 'Geo' and 'Morpho'. The 'geo' means earth while 'morpho' means shape, setting or arrangement. Hence, Geomorphology is the scientific discipline concerned with surface and features of the earth, including the landforms and forms under the ocean and the physical, chemical and biological factors, such as weathering, erosion and wave actions that act on them (Dorothy, 1990). Geomorphology is also defined as the study of the nature and origin of landforms, particularly of the formative processes of weathering and erosion that occur in the atmosphere and hydrosphere (Brooks, 2013).

The continent of Africa is an island with surface area of 30,310,000km^2 and bounded by the Atlantic Ocean on the western and southern margins, the Indian Ocean on the southeastern, and the Mediterranean Sea in the North and Red sea in the north eastern margin (Fig. 1). The continent which forms very large and relatively uniform landmass of plateau, estuaries and inland basins represents one-fifth of the total land surface of the earth and is characterized by interesting landscape.

Figure:1 World Continents showing position of Africa

3.2 Factors that are responsible for Geomorphology Variations

Volcanism

Volcanism is a term use to describe the movement of hot magma (liquid from melting of rocks) from the point of generation to the surface through vents (cracks). This process is usually associated with earthquake, which may be due to collision of lithospheric plates (solid earth) or any other natural occurrence. When the "hot magma" has dropped in temperature, it will begin to cool into different shapes of solid materials called **volcanoes** (Fig. 2)**.** Most rocks that are seen around us today are products of volcanism and are still undergoing weathering action.

How the magma generates
To understand where volcanoes come from, one must first examine the origin of magma; hot, molten rock that wells up from deep within the earth to extrude from fractures as lava flows and/or pyroclastic ejecta. The source for magma is not the earth's liquid outer core, but generated at the relatively shallow depths of 100 to 300 km, through the partial melting of the earth's crust and mantle. It is most often formed by decompression-melting of asthenosphere associated with divergent plate boundaries or mantle plumes, or by partial-melting of water-rich crust and/or asthenospheric material in association with subduction at convergent plate boundaries.

The ingredients necessary for the production of magma involve the interplay between heat, pressure, intra-granular fluids (present as gases within very hot rock or magma), and the composition of the material subject to melting. Heating obviously brings solids closer to their melting points, the more heat, the more likely a solid will melt. In general, higher pressures prevent melting because the constituent atoms of minerals in rocks are squeezed

together and remain solids under high pressure. Consequently, lowering pressure on hot rock induces melting. Intra-granular fluids lower the melting point of solids, so the presence of fluids (gases), generally water, allows solid rock to melt at a lower temperature (or heat content) than it otherwise would. Finally, there are two general trends to explore in relation to rock composition: rock that contains a relative abundance of silica (SiO_2) and aluminum (aluminum oxide) will melt at a lower temperature (heat content); while a rock containing a relative abundance of ferromagnesian (Fe, Mg, and Ca) ions will melt at higher temperatures (heat content).
The melting of continental crust generates felsic magma enriched in silica and aluminum, while melting of mantle rock (asthenosphere) and oceanic crust forms ferromagnesian-rich, mafic magma. The earth's crust naturally contains higher water content (because of its proximity to the hydrosphere) than the mantle, accounting for higher water (and thus gas) content in felsic to intermediate magmas. The relatively high content of silica and water in continental crust also correlates with the lower melting temperatures of felsic to intermediate magmas. Mantle material melts at greater depth and higher temperatures and pressures, not requiring as much "assistance" from silica and water in the melting process.

The composition of magma depends on three main factors:

i) degree of partial melting of the crust or mantle;
ii) degree of magma mixing; and
iii) magmatic differentiation by fractional crystallization.

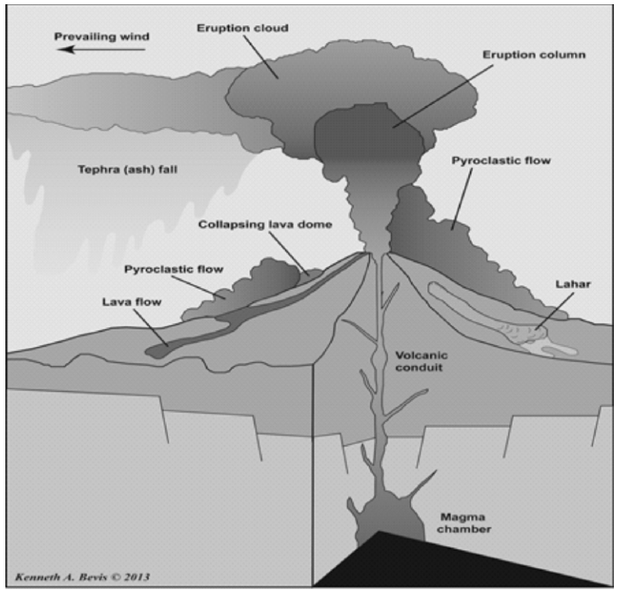

Figure 2: Common magma and volcanoe formative processes

Weathering

Weathering is the group of destructive processes that change the physical and chemical characteristics of rocks at or near surface. The process can be **mechanical**, **chemical or biological. Mechanical** weathering is the physical disintegration of rocks into loose sediments by agents such as temperature changes, pressure release due to unloading of overlying materials, crystal growth and frost action. In frost action, the water that has trickled into cracks in rocks can freeze and expand by about 9% when temperature drops below 0^0C (32^0F). The expanding ice pushes the rock apart, extends the joints and breaks the rocks into pieces of different shapes. **Chemical** weathering is the decomposition of rocks in the presence of active water, low temperature, oxygen and CO_2. The chemical composition of the new product may be completely different from the parent material. Chemical such as acid-water solution that dislodges and dissolves the tightly bound minerals of rocks into new products in the presence of water and air **Biological weathering** involves actions of microorganisms and plant roots on soils to further disintegrate them to smaller sizes. The three bring about soil formation which is always overlying the rocks. However, the type of weathering processes that occur at any particular place depend on the climate.

Weathering Controls Elements
The type, rate and extent of weathering depend upon several factors:

Climate: This dictates the type of weathering processes that operate, largely by determining the amount of water available and the temperature at which the processes occur. For instance, chemical reactions are faster in higher temperature while frost wedging is common in colder climates.
Topography: The slope angle determines the energy of the weathering system by controlling the rate at which water passes through the rock mass. Generally, "tectonically" active areas with steeper slopes have more dynamic weathering system, however, flat or plains have slower weathering systems.
Rock Structure: Rocks that are highly jointed present many planes of weaknesses along which chemically active water (agent of weathering) can penetrate.
Rock Types: determines the resistance of the rock to the weathering processes that operate in that particular environment. Each rock type is composed of a particular set of minerals, which are joined together by crystallization, chemical bonding or cementing. When the forces of plate tectonics move these rocks from the environment in which they formed and expose them to the atmosphere they begin to weather.
Time: the duration of the period that the same type of weathering has been operating, uninterrupted by climatic change, earth movements, and other factors, determines the degree and depth to which the rocks have been weathered

Erosion

This is the removal (transport) of weathered rock materials downslope, and away, from their original site of weathering. Erosion processes are driven primarily by the force of gravity, which may be aided by a flowing medium such as water (e.g. rivers), and ice (e.g. glaciers), or gravity may act alone (e.g. rockfalls). Wind can also remove weathered materials (e.g. deflation).

During transportation of the weathered rock materials, the angular particles commonly abrade (rub or scour) the surfaces over which they pass, wearing away and lowering the rocks. Thus, landslide debris may erode the slope or channel along its course, the sediments in rivers erode the rocky sections of their beds, and the rock fragments in glaciers erode the valley floor.
Erosion Processes

These are usually considered under four distinct categories:

- **Mass Wasting**: the processes that occur on slopes, under the influence of gravity, in which water may play a part, although water is not the main transporting medium. Mass wasting, or landsliding.
- **Fluvial**: the processes that involve flowing water, which can occur within the soil mass (e.g. soil piping), over the land surface (e.g. rills and gullies), or in seasonal or permanent channels (e.g. seasonal streams and rivers).

Erosion Controls
The type and magnitude of erosion depends upon several factors including:

- **Climate**: exerts a fundamental control on the types and rates of erosion in an area, because climate determines the amount and seasonal distribution of water (rainfall), the temperature (tropical, temperate or polar), and factors such as the sunshine hours, the wind strengths, and wind patterns.
- **Topography**: mountain areas have a higher elevation and thus greater potential energy than the lowlands. This, combined with the steeper slope angles, results in more dynamic erosion in upland areas than on the surrounding plains.
- **Rock Type**: the type of rock determines how susceptible an area is to erosion. Within the same climatic regime, each rock type responds differently to weathering and erosion, exhibiting a characteristic resistance or weakness to the prevailing conditions. Thus, some rocks are relatively resistant and form higher ground, whereas others are less-resistant and form valleys and lowlands.
- **Rock Structure**: highly jointed or faulted rocks are usually more intensely weathered along the lines of weakness in the rock mass. Consequently, these softer weathered materials are more easily eroded out, with the result that river valleys are usually located along the line of a major fault or joint set.

The ultimate result of erosion is to reduce all mountains, ridges, and high ground to a flat plain (termed a peneplain) that slopes very gently from the centre of a landmass to the sea.

Landslides

Landsliding, or slope failure, is a general term that encompasses the gravity-controlled, mass wasting processes that affect hill slopes (earth surface) throughout the world.

Natural Slopes
Under normal circumstances, natural slopes (i.e. slopes that are largely unmodified by human activities) reach a state of quasi-equilibrium, in which the slope is eroded to an angle that is relatively stable with regard to the underlying rock type and structure, the soil type

and thickness, the extent and type of the vegetation cover, the surface and subsurface hydrology, and the prevailing climatic conditions and local weather patterns.

Weathering processes continually act upon the slopes, weakening the underlying rocks. Groundwater flushes-out some of the weathered materials from the joints in the rocks and from the overlying soils, and hillside streams deepen their channels.

The rocks and soils of the slope progressively become weaker and less stable, so sections of the slope periodically readjust to a more stable profile by failing (landsliding)
Importantly, if one or other of the factors on the slope changes, such as the tree cover is removed by fire or forestry, or an exceptionally heavy rainfall occurs, then large areas of a hillside may be subject to erosion, including failure (landslide).

In addition, steep stream courses carry considerable amounts of surface runoff during heavy rainstorms. This water, and the included debris, can severely erode the stream channel, destabilising the stream banks and the adjacent slopes, triggering slope failures. In extreme circumstances, earthquakes may shake an area and loosen large masses of material, causing landslides or disturbing the previous equilibrium.
Man-made Slopes
This process creates a very steep cutting (a cut slope), which changes the geometry of the original slope, affects the groundwater regime, and may expose unfavourably oriented joint planes or other lines of weakness within the rock

Man-made slopes are, by their very nature, steeper than most natural slopes. They are not in a natural equilibrium with the profile of the original hillside into which they are excavated. Consequently, some forms of engineering stabilisation works are normally required.

Failures of man-made slopes primarily occur along joint planes in fresh rock, and in some cases along relict joint planes in weathered rock. These discontinuities, which are commonly clay-filled present lines of weakness that allow blocks of material to become detached from the slope when the friction on the plane is overcome, or when the material that originally supported the toe of the slope is removed.

4.0 Summary

The unit discussed the concept of geomorphology, factors that are responsible for geomorphological variations.

5.0 Self-Assessment Questions (SAQs)

(i) explain the concept of Geomorphology
(ii) discuss factors which are responsible for geomorphological variations –volcanism, weathering, erosion and landslide; and
(iii) explain reason for geomorphological variations in Africa countries

6.0 Tutor Marked Assessment

List and discuss the 3 factors that composition of magma depends on

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UNIT 2 MORPHOLOGY OF AFRICA

Contents

1.0 Introduction

The unit will discuss morphology of Africa, looking into the hydrography and drainage as well as the morphology of the Ocean Floor.

2.0 Learning Outcomes

At the end of this unit, you should be able to:

(i) describe important physical features in Africa, especially Nigeria; and
(ii) explain morphological characteristics of the ocean floor.

3.0 Main Contents

3.1 Surface Morphology of Africa

Rocks and Relief

The surface of the Africa continent is occupied by different rock types (Fig. 3). The rocks are different in terms of their occurrence, ages and origin etc. Some of the rocks are hard/crystalline (called Basement rocks). These rock types include those that are formed as a result of the solidification of hot liquid (magma) that move through vents (cracks or openings) in existing rocks and those that are formed through the process of metamorphism (transformation of rocks from one form to another under the influence high temperature, pressure, water and tectonic activities). Examples of such rocks are those within and around the university campus. However, some are loose/soft (called sedimentary rocks or sediments). These are deposited materials that have been transported from weathered crystalline rocks or existing sedimentary rocks by such agents as water erosion, ice and wind. They are different from the crystalline rocks in that they are deposited in layers (beds) each layer being different from another in composition, particle size, morphology, etc. they are restricted to basin areas and covered by earth materials except where exposed through road-cuts or landslides. Such exposures are noticeable along Lokoja – Abuja Road. The rocks are also different in ages ranging from the 'older rocks' (called the PreCambrian) to the 'Recent' sediments. The emplacement of these rock types and the effects of associating erosional processes resulted in the ever changing morphology of the earth surface. The major source of different relief characterizing the surface of Africa is tectonic activities (deformative processes that involve earthquake and volcanism) which took place over 600ma, called Pre-Cambrian age (Petters, 1991).

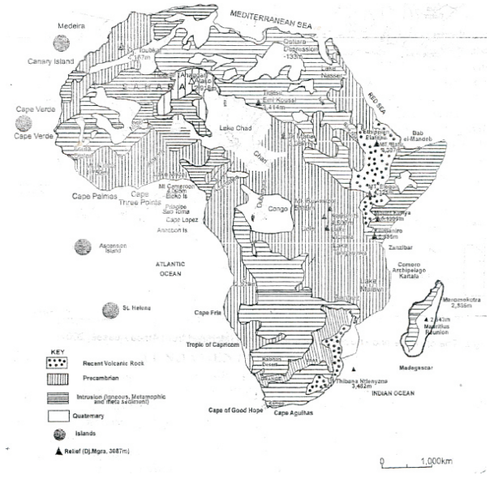

Fig. 3: Geology of Africa showing the Islands (Africa Atlasses,2007)

These activities, though relatively stable since then, resulted in several different elevations called Hills (mountains) and valley today (Fig. 3). The relief is higher towards the north (approximately 300m) from the southern and western margins. The Saharan (north) plateaus are dominated by the Hoggar, Darfur and Tibesti ranges. The relief in the Eastern and Southern Africa is more compartmentalized than anywhere. Troughs caused by faults in the bedrock form the rifts valley which runs roughly north to south over 4000km. The blocks which were raised on either side formed the upland plateaus which culminate in mountain ranges. Such mountains include the Ruwenzori in Uganda (5,119m), Elgon (4, 321m), Karisimbi (4,507m), Batu (4,307m), Batu (4,307m) and Kilimanjaro (5, 895m). These mountains are products of volcanic activities. Other important mountains in Africa are briefly discuss below,

Atlas Mountains: This mountain system runs from southwestern Morocco along the Mediterranean coastline to the eastern edge of Tunisia. Several smaller ranges are included, namely the High Atlas, Middle Atlas and Maritime Atlas. The highest peak is Mt. Toubkal in western Morocco at 13,671 ft. (4,167 m).

Ethiopian Highlands: The Ethiopian Highlands are a rugged mass of mountains in Ethiopia, Eritrea (which is sometimes referred to as the Eritrean Highlands), and northern Somalia in the Horn of Africa. The Ethiopian Highlands form the largest continuous area of its altitude in the whole continent, with little of its surface falling below 1500 m (4,921 ft), while the summits reach heights of up to 4550 m (14,928 ft). It is sometimes called the Roof of Africa for its height and large area.

Hoggar (Ahaggar) Mountains: The Hoggar Mountains, also known as the Ahaggar, are a highland region in central Sahara, or southern Algeria, along the Tropic of Cancer. They are located about 1,500 km (900 mi) south of the capital, Algiers and just west of Tamanghasset. The region is largely rocky desert with an average altitude of more than 900 metres (2,953 feet) above sea level. The highest peak is at 3,003 meters (Mount Tahat).

Kalahari Desert: It's about 100,000 sq. miles (259,000 sq. km) in size and covers much of Botswana, the southwestern region of South Africa and all of western Namibia. The desert plateau is criss-crossed by dry rivers beds and dense scrub. A few small mountain ranges are situated here including the Karas and the Huns. Large herds of wildlife are found in the Kalahari Gemsbok National Park, located in South Africa near its border with Namibia. **Namib Desert:** The Namib is a coastal desert in southern Africa that stretches for more than 2,000 km (1,200 mi) along the Atlantic coasts of Angola, Namibia, and South Africa, extending southward from the Carunjamba River in Angola, through Namibia and to the Olifants River in Western Cape, South Africa. From the Atlantic coast eastward, the Namib gradually ascends in elevation, reaching up to 200 km (120 mi) inland to the foot of the Great Escarpment. Annual precipitation ranges from 2 mm (0.079 in) in the most arid regions to 200 mm (7.9 in) at the escarpment, making the Namib the only true desert in southern Africa. The Namib is also the oldest desert in the world and its geology consists of sand seas near the coast, while gravel plains and scattered mountain outcrops occur further inland. The desert's sand dunes, some of which are 300 m (980 ft.) high and span 32 km (20 mi) long, are the second largest in the world after the Badain Jaran Desert dunes in China

Sahel Desert: The Sahel is a wide stretch of land running completely across north-central

Africa, just on the southern edges of the ever-expanding Sahara Desert. This border region is the transition zone between the dry areas of the north and the tropical areas of the south. It receives very little rain (six - eight inches a year) and most of the vegetation is a savanna growth of sparse grasses and shrubs.

Sahara Desert: Covering almost one-third of the continent, the Sahara is the largest desert in the world at approximately 3,500,000 sq. miles (9,065,000 sq. km) in total size. Topography includes areas of rock-strew plains, rolling sand dunes and numerous sand seas. It ranges in elevation from 100 ft. below sea level, to peaks in the Ahaggar and Tibesti mountains that exceed 11,000 ft. (3,350m). Regional deserts include the Libyan, Nubian and the Western desert of Egypt, just to the west of the Nile. Almost completely without rainfall, a few underground rivers flow from the Atlas Mountains, helping to irrigate isolated oases. In the east, the water is of the Nile help fertilize smaller parts of the landscape.

3.2 Hydrography and Drainage

The hydrographic characteristic of the African continent is restricted to places with high rainfall. Vast land area of Africa has no river flowing to the sea (Endoreism). Such areas lie in the arid zone stretching from the Atlantic to the Red sea except River Nile in Egypt (6,670km) which drains to the Mediterranean Sea. In such areas, rain water either evaporates back to atmosphere or infiltrates the subsurface.

Like other places in the world, water accumulates in the depressions, basins, troughs and lakes created by several rift systems. The lakes are often narrow and sometimes very deep. For instance, the Lake Tanganyika in Tanzania plunges to a depth of 1,435m and Lake Victoria (largest lake in Africa) with total area of 83,000km^2. Also, terrain irregularities initiate the associating rapid and waterfalls along the rivers system. The water from the atmosphere, basins, lakes etc. is ultimately drained into the ocean by several rivers, streams, and rivulets of the surface of Africa. Some of these rivers drain to Lake Chad, the rivers Niger and Benue confluence at Lokoja and empty into the Atlantic Ocean through the Niger delta. The important rivers in Africa include the Nile (6400km), Niger (4160km), Congo (4800km) and Zambezi (3000km) (Fig. 4). The important lakes in Africa include the Kivu (Burundi), Turkana (Kenya), Edward (Rwanda), and Tanganyika (Tanzania). Others are Lake Malawi, Lake Nweru, and Lake Victoria etc., which also form part of drainage system. The following river systems are emphasized because of their great influencing in the definition of drainage pattern of Africa

***Congo River Basin*:** The Congo River Basin of central Africa dominates the landscape of the Democratic Republic of the Congo and much of neighboring Congo. In addition, it stretches into Angola, Cameroon, the Central African Republic and Zambia. The fertile basin is about 1,400,000 sq. miles (3,600,000 sq. km) in size and contains almost 20% of the world's rain forest. The Congo River is the second longest river in Africa, and it is network of rivers, tributaries and streams help link the people and cities of the interior.

***Great Rift Valley*: This is a** dramatic depression on the earth's surface, approximately 4,000 miles (6,400 km) in length, extends from the Red Sea area near Jordan in the Middle East, south to the African country of Mozambique. In essence, it's a series of geological faults caused by huge volcanic eruptions centuries back, that subsequently created what we now

call the Ethiopian Highlands, and a series of perpendicular cliffs, mountain ridges, rugged valleys and very deep lakes along it is entire length. Many of Africa's highest mountains front the Rift Valley, including Mount Kilimanjaro, Mount Kenya and Mount Margherit

Nile River System: The longest river in the world (flows north), rising from the highlands of southeastern Africa and running about 4,160 miles (6,693 km) in length, to then drain in the Mediterranean Sea. In simple terms it's a series of dams, rapids, streams, swamps, tributaries and waterfalls. Numerous (major) rivers comprise the overall system, including the Albert Nile, Blue Nile, Victoria Nile and White Nile.

Fig. 4: Drainage Pattern of Africa (Africa Atlasses, 2007)

3.3 Morphology of the Ocean Floor

Like the surface of the earth, the floor of the ocean is also characterized by several features of different shapes. The African continent has two margins (edges) - the passive and active margins. The passive margin is the one that develops on geologically quiet coast that is void of earthquake, volcanoes and young mountain belt. The active continental margin, usually associated with the convergent plates boundaries (where two continental plates collide), is typically characterized by earthquakes, volcanoes and associating young mountain belts (Plummer *et al*., 2007). Hence, morphological features of the ocean floor are restricted to the active continental margins. Examples of such features include the Mid Oceanic Ridge, the Seamounts and the Guyots.

Mid Oceanic Ridge: This is a giant undersea mountain range that extends around the globe like seams on a base ball. Along the African plate, it is more than 8, 000km long, 2,500km wide and rise 3km above the ocean floor.
Seamounts: These are conical mountains on the sea floor associated with the Mid-Oceanic Ridge. They occasionally rise above the sea level to form islands
Guyots: These are flat-topped seamounts. The flat top which are generally below the sea level are due to cutting action of sea waves.

1.0 Summary

In this unit, we identified the river systems because of their great influencing in the definition of drainage pattern of Africa. Also, we discussed the morphology of the ocean floor.

2.0 Self-Assessment Questions (SAQs)

(i) describe important physical features in Africa, especially Nigeria; and
(ii) explain morphological characteristics of the ocean floor.

6.0 Tutor Marked Assessment

Write concise notes on the following:
i. 5 Products of volcanic activities
ii. Morphology of Ocean Floor
iii. Hydrography and Drainage

7.0 Further Reading

Petters, S.W (1991). Regional Geology of Africa. Springer – Verlag, Berlin.
Plummer, C.C, McGeary. D. and Carlson, D.H. (2007). Physical Geology. McGraw Hill. 10th Edition, 580p
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World Atlas (2017). http://www.worldatlas.com/webimage/countrys/aflnd.htm
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