NATIONAL OPEN UNIVERSITY OF NIGERIA

FACULTY OF HEALTH SCIENCES

COURSE CODE: EHS507

COURSE TITLE: ENVIRONMENTAL HEALTH LABORATORY

COURSE GUIDE

EHS 507
ENVIRONMENTAL HEALTH LABORATORY

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Printed 2018, 2019

ISBN: 978-978-970-095-X

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INTRODUCTION

EHS507 ENVIRONMENTAL HEALTH LABORATORY PRACTICE is a two (2) unit course with five (5) modules and eighteen (18) units. Environmental health is the scientific study of the challenges that are facing our environment, either naturally or as a result of human activities. The environment becomes affected when pollutants are released into it through human's exploration of natural resources. Microbiological and parasitological techniques are the technical knowledge that has to do with the studying and understanding microbes in the environment through scientific studies. The effects of pollutants and microbes on the environment are interrelated and have significant effects on the environment. They both cause damage to the environment and living organisms.

WHAT YOU WILL LEARN IN THE COURSE

In this course, you have the course units and a course guide. The course guide will tell you what the course is all about. It is the general overview of the course materials you will be using and how to use those materials. It also helps you to allocate appropriate time to each unit so that you can successfully complete the course within the stipulated time limit.

The course guide also helps you to know how to go about your Tutor-Marked Assignment (TMA), which will form part of your overall assessment at the end of the course. Also, there will be regular tutorial classes that are related to this course, where you can interact with your facilitator and other students. Please, I encourage you to attend the tutorial classes.

COURSE AIM

The course aims to give you an understanding of Environmental Health, which is an important branch of Life Sciences.

COURSE OBJECTIVES

To achieve the aim set above, there are objectives. Each unit has a set of objectives presented at the beginning of the unit. These objectives will give you on what to concentrate / focus on while studying the unit. Please read the objectives before and during your study to check your progress.

The comprehensive objectives of the course are given below. By the end of the course/after going through this course, you should be able to:

i. understand the concepts of chemistry in the environment
ii. explain major chemical elements that causes hazards to human and his environment
iii. know the sources of chemical elements that cause hazards in the environment
iv. know the source of environmental chemistry pollution
v. understand the pathway through which these chemicals are dispersed into the environment
vi. understand the effect on the environment
vii. find remedy to the environmental chemistry pollution
viii. advocate for sustenance of safer environment and prevent environmental pollution
ix. know the techniques in microbial studies
x. distinguish between pathogenic and non-pathogenic microbes
xi. know some methods used in handling pathogenic microbes
xii. know the safety precautions in handling microbes.
xiii. explain parasitological terms
xiv. be knowledgeable about parasites and their hosts
xv. explain host-parasite relationship
xvi. explain and discuss radiation
xvii. understand the sources of radiation
xviii. explain ionizing and non-ionising radiation
xix. know ways in which radiation gets to humans and other living organisms
xx. understand how radiation ~~it~~ affects living organisms
xxi. adopt protective measures against radiation exposure
xxii. explain the meaning pests
xxiii. discuss the various types of pests
xxiv. highlight the importance of pests in our environment
xxv. highlight control strategies of pests of medical importance
xxvi. understand the concept of pest management
xxvii. discuss various tools used in pest management
xxviii. know the pros and cons of control strategies used in pest management
xxix. define pesticide

xxx. know the uses of pesticides
xxxi. know the safety precaution in using pesticides.
xxxii. know the terminologies used in pesticides
xxxiii. chemical nature of pesticides
xxxiv. know how to formulate pesticides
xxxv. explain the meaning of allergy
xxxvi. discuss common causes of allergy
xxxvii. describe how our body responds to allergic condition
xxxviii. list the elements that are responsible for allergy
xxxix. understand and explain the term crude oil (petroleum)
xl. know the source of crude oil
xli. know the uses of crude oil
xlii. highlight the effect of oil spill on the environment
xliii. know what gas flaring means
xliv. know the hazards associated with gas flaring
xlv. know the control strategies on oil disaster related cases
xlvi. understand the concepts of environmental impact assessment
xlvii. understand the act that established eia
xlviii. describe the role of law enforcement agents in eia
xlix. define audit and its application(s)
l. know the methods involved in environmental audit
li. understand the use of environmental statement in handling environmental challenges
lii. know how remote sensor operate
liii. be knowledgeable in the application of remote sensing based on distance
liv. know the different types of sensors
lv. understand the interaction between object and spectrum
lvi. understand the function of space-borne sensor
lvii. know what is stands for
lviii. know is and its technology
lix. be knowledgeable in the application of is in environmental solutions.

WORKING THROUGH THIS COURSE

To successfully complete this course, you are required to read each study unit and the textbooks materials provided by the National Open University of Nigeria. Reading the referenced materials can also be of great assistance. Each unit has self-assessment exercises, which you are encouraged to do and at certain periods during the course, you will be required to submit your assignment for the purpose of assessment.

There will be a final examination at the end of the course. The course should take you about 17 weeks to complete. The course guide will provide you with all the components of the course, how to go about studying and the time/hour you should allocate to each unit so as to finish on time and successfully too.

THE COURSE MATERIALS

The main components of the course are:

- The Study Guide
- Study Units
- Reference / Further Reading
- Assignments
- Presentation Schedule

STUDY UNITS

The study units in this course are given under each module as shown below:

MODULE 1 ENVIRONMENTAL CHEMISTRY

Unit 1 Environmental Chemistry
Unit 2 Why study Environmental Chemistry?
Unit 3 Remedy to Chemical in the Environment

MODULE 2 TECHNIQUES IN PARASITOLOGY, MICROBIOLOGY AND ALLERGY

Unit 1 Techniques in Microbiology
Unit 2 Techniques in Parasitology
Unit 1 Principles of Allergy

MODULE 3 PEST MANAGEMENT STRATEGIES AND PESTICIDE FORMULATION

Unit 1 Concept of Pest
Unit 2 Methods of Pest Management
Unit 3 What are Pesticides?
Unit 4 Types of Pesticides

MODULE 4 RADIATION, OIL SPILL, GAS FLARING, AND ENVIRONMENTAL MANAGEMENT TECHNIQUES

Unit 1 Radiation and the risk of exposure
Unit 2 Oil Spill in the Environment, Gas Flaring and Control Strategy of Oil Disaster
Unit 3 Environmental Impact Assessment, Audit and Statement
Unit 4 Remote Sensing and Geographical Information System in Environmental Health

There are activities related to the lecture in each unit, which will help your progress and comprehension of the unit. You are required to work on these exercises which together with the Tutor-Marked Assessments (TMAs) will enable you to achieve the objectives of each unit.

ASSIGNMENT FILE

There are two types of assessments in this course. First is the Tutor-Marked Assessments (TMAs); the second is the written examination. In solving the questions in the assignments, you are expected to apply the information, knowledge and experience acquired during the course. The assignments must be submitted to your facilitator for formal assessment in accordance with prescribed deadlines stated in the assignment file. The work you submit to your facilitator for assessment accounts for 30 percent of your total course mark. At the end of the course, you will be required to sit for a final examination of 3½ hours duration at your study center. This final examination will account for 70 % of your total course mark.

PRESENTATION SCHEDULE

There is a time-table prepared for the early and timely completion and submissions of your TMAs as well as attending the tutorial classes. You are required to submit all your assignments by the stipulated time and date. Avoid falling behind the schedule time.

ASSESSMENT

There are three aspects to the assessment of this course. The first one is the self-assessment exercise. The second is the tutor-marked assignments and the third is the written examination or the examination to be taken at the end of the course. Do the exercises or activities in the units by applying the information and knowledge you acquired during the course. The TMAs must be submitted to your facilitator for formal assessment in accordance with the deadlines stated in the presentation schedule and the assignment file. The work submitted to your tutor for assessment will count for 30% of your total course work. At the end of this course, you have to sit for a final or end of course examination of about a three-hour duration which will count for 70% of your total course mark.

TUTOR-MARKED ASSIGNMENT

This is the continuous assessment component of this course and it accounts for 30% of the total score. You will be given four (4) TMAs by your facilitator to answer. Three of which must be answered before you are allowed to sit for the end of course examination.

These answered assignments must be returned to your facilitator. You’re expected to complete the assignments by using the information and material in your readings references and study units. Reading and researching into your references will give you a wider via point and a deeper understanding of the subject.

1. Make sure that each assignment reaches your facilitator on or before the deadline given in the presentation schedule and assignment file. If for any reason you are not able to complete your assignment, make sure you contact your facilitator before the assignment is due to discuss the possibility of an extension. Request for extension will not be granted after the due date unless there in exceptional circumstances.
2. Make sure you revise the whole course content before sitting for the examination. The self-assessment activities and TMAs will be useful for this purpose and if you have any comments, please do before the examination. The end of course examination covers information from all parts of the course.

Table 1: Course Marking Scheme

Assignment	Marks
Assignments 1-4	Four assignments, best three marks of the four count at 10% each = 30% of course marks
End of course examination	70% of overall course marks
Total	**100% of course materials**

Table 2: Course Organisation

Unit	Title of Work	Weeks Activity	Assessment (End of Unit)
	Course Guide	**Week**	
1 and 2	Environmental Chemistry; Why Study Environmental Chemistry?	Week 1	Assignment 1
3 and 4	Remedy to Chemical in the Environment; Techniques in Microbiology	Week 2	Assignment 2
5 and 6	Techniques in Parasitology; Principles of Allergy	Week 3	Assignment 3
7 and 8	Principles of Allergy; Concept of Pest	Week 4	Assignment 4
9 and 10	Methods of Pest Management; What are Pesticides?	Week 5	Assignment 5
11 and 12	Types of Pesticides; Radiation and the Risk of Exposure	Week 6	Assignment 6
13	Oil Spill in the Environment, Gas Flaring and Control Strategy of Oil Disaster	Week 7	Assignment 7
14	Environmental Impact Assessment, Audit and Statement	Week 8	Assignment 8
15	Remote Sensing, Geographical Information System in Environmental Health	Week 9	Assignment 9

However, you will be asked to submit only 4 of these assignments

HOW TO GET THE MOST OUT OF THIS COURSE

In distance learning, the study units replace the university lecturer. This is one of the huge advantages of distance learning mode; you can read and work through specially designed study materials at your own pace and at a time and place that suit you best. Think of it as reading from the teacher, the study guide tells you what to read, when to read and the relevant texts to consult. You are provided exercises at appropriate points, just as a lecturer might give you an in-class exercise.

Each of the study units follows a common format. The first item is an introduction to the subject matter of the unit and how a particular unit is integrated with the other units and the course as a whole. Next to this is a set of learning objectives. These learning objectives are meant to guide your studies. The moment a unit is finished, you must go back and check whether you have achieved the objectives. If this is made a habit, then you will significantly improve your chances of passing the course
The main body of the units also guides you through the required readings from other sources. This will usually be either from a set book or from other sources.

Self-assessment exercises are provided throughout the unit, to aid personal studies and answers are provided at the end of the unit. Working through these self-tests will help you to achieve the objectives of the unit and also prepare you for tutor marked assignments and examinations. You should attempt each self-test as you encounter them in the units.

The following are practical strategies for working through this course

1. Read the Course Guide thoroughly.
2. Organise a study schedule. Refer to the course overview for more details. Note the time you are expected to spend on each unit and how the assignment relates to the units. Important details, e.g. details of your tutorials and the date of the first day of the semester are available. You need to gather together all this information in one place such as a diary, a wall chart calendar or an organizer. Whatever method you choose, you should decide on and write in your own dates for working on each unit.
3. Once you have created your own study schedule, do everything you can to stick to it. The major reason that students fail is that they get behind with their course works. If you get into difficulties with your schedule, please let your tutor know before it is too late for help.
4. Turn to Unit 1 and read the introduction and the objectives for the unit.
5. Assemble the study materials. Information about what you need for a unit is given in the table of contents at the beginning of each unit. You will almost always need both the study unit you are working on and one of the materials recommended for further readings, on your desk at the same time.
6. Work through the unit, the content of the unit itself has been arranged to provide a sequence for you to follow. As you work through the unit, you will be encouraged to read from your text books.
7. Keep in mind that you will learn a lot by doing all your assignments carefully. They have been designed to help you meet the objectives of the course and will help you pass the examination.
8. Review the objectives of each study unit to confirm that you have achieved them. If you are not certain about any of the objectives, review the study material and consult your tutor.
9. When you are confident that you have achieved a unit's objectives, you can start on the next unit. Proceed unit by unit through the course and try to pace your study so that you can keep yourself on schedule.
10. When you have submitted an assignment to your tutor for marking do not wait for its return before starting on the next unit. Keep to your schedule. When the assignment is returned, pay particular attention to your tutor's comments, both on the tutor-marked assignment form and also that written on the assignment. Consult your tutor as soon as possible if you have any questions or problems.
11. After completing the last unit, review the course and prepare yourself for the final examination. Check that you have achieved the unit objectives (listed at the beginning of each unit) and the course objectives (listed in the Course Guide).

FACILITATORS/TUTORS AND TUTORIALS

Sixteen (16) hours are provided for tutorials for this course. You will be notified of the dates, times and location for these tutorial classes. As soon as you are allocated a tutorial group, the name and phone number of your facilitator will be given to you.

These are the duties of your facilitator: He or she will mark and comment on your assignment. He will monitor your progress and provide any necessary assistance you need. He or she will mark your TMAs and return to you as soon as possible. You are expected to mail your tutored assignment to your facilitator at least two days before the scheduled date.

Do not delay to contact your facilitator by telephone or e-mail for necessary assistance if you do not understand any part of the study unit in the course material. If you have difficulty understanding self-assessment activities in the unit; or an assignment is not clear and the grading of the assignment consults your facilitator.

It is important and necessary you attend the tutorial classes because this is the only chance to have face to face content with your facilitator and to ask questions, which will be answered instantly. It is also the period where you can highlight any problem encountered in the course of your study.

FINAL EXAMINATION AND GRADING

The final examination for EHS 507: Environmental Health Laboratory Practice I, will be of 1½ hours duration. This accounts for70% of the total course grade. The examination will consist of questions which reflect the practice, exercises and the tutor-marked assignments you have already attempted in the past. Note that all areas of the course will be assessed. To revise the entire course, you must start from the first unit to the eighteenth unit in order to get prepared for the examination. It may be useful to go over your TMAs and probably discuss with your course mates or group if need be. This will make you to be better prepared, since the examination covers information from all aspects of the course.

SUMMARY

Environmental health is a course that exposes you to the scientific study of some environmental challenges that affect man and his environment. This course emphasises on the effect of natural and man-made disasters that affect the environment. Techniques and concepts in understanding of environmental challenges as well as microbiological and parasitological investigations are highlighted in this course. It can be said that Environmental Health is the scientific study of challenges that affect man and his surroundings. The effects of the environmental challenges maybe on water, land, atmosphere, man and other living or non-living organisms.

On completion of this course, you will have an understanding of basic knowledge of environmental chemistry, man-made and natural disasters, ways of understanding those disasters and remedies, some basic concepts in studying microbes and parasites. In addition, you will be able to answer questions on:

- Definition of the term Environmental Health
- Disasters affecting the environment
- Importance of Environmental Health
- Ways of remedying environmental challenges
- Microbiological techniques in the study of microbes.
- Why parasitology is considered an important discipline in life sciences
- Gas flaring

The questions you are expected to answer are not limited to the above list. Finally, you are expected to apply the knowledge you have acquired during this course to your practical life.

I wish you success in this course!

MAIN COURSE

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MODULE 1 ENVIRONMENTAL CHEMISTRY

UNIT 1 CONCEPTS OF ENVIRONMENTAL CHEMISTRY

CONTENTS

1.0 INTRODUCTION

In this unit, we shall study the concepts of Environmental Chemistry and how it affects the environment. Environmental Chemistry is one of the major challenges that affect our environment that requires adequate attention.

2.0 OBJECTIVES

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

- understand the concepts of environmental chemistry
- explain major chemical elements that cause hazards to humans and their environment
- know the sources of chemical elements that cause hazards in the environment.

3.0 MAIN CONTENT

3.1 Environmental Chemistry

Environmental Chemistry is an interdisciplinary science that includes chemistry of the air, water, and soil. Although it may be confused with green chemistry, which deals with potential pollution reduction, Environmental Chemistry is the scientific study of the chemical and biochemical principles that occur in nature. Therefore, it is the study of the sources, reactions, transport, effects, and fates of chemical elements/components in soil, air, water and food, and the effect of human activity on them. Environmental Chemistry not only explores soil water and food, but also closely examines the interfaces and boundaries where the environments intersect. As environmental chemistry seeks to understand the effect of chemicals on the environment, it also seeks to know the concentration and effect of naturally occurring chemicals and elements. Without this knowledge, it is nearly impossible to accurately study the effects of chemical processes on the environment. The field of Environmental Chemistry is fluid and continues to evolve and change. As we learn more about the environment around us, we learn that slight changes in one area may have drastic consequences on another. A principle of Environmental Chemistry bridges the important environmental media such as soil, air, water and food, and also describes how these media influence other environment. The breakdown and impact of chemicals differ within and between each media, the impact may continue through more than one media and cycle back to the original media.

Furthermore, environmental scientists examine chemical elements/components in our surroundings. This is a broad interdisciplinary undertaking, bringing together atmospheric, aquatic, and soil scientists. Analytical chemistry methods are especially important for identifying and quantifying chemical elements/components that are often present in complex mixtures in very small quantities. The source, role, and fate of environmental contaminants, which are chemical species present in nature due to human activity, are often a focus of environmental scientists.

Environmental Chemistry may also be viewed as the study of the reactions, sources, transport, effects, and fates of chemical species in water, air, soil, and living environments, and the effects of technology. Environmental Chemistry is a branch of chemistry containing features related to organic, physical, analytical, and inorganic chemistry as well as more diverse areas, such as public health, biochemistry, toxicology, and epidemiology. Environmental Chemistry is the study of chemical processes happening in the environment, which are impacted by mankind's activities and the impacts may be felt through the presence of air pollutants or toxic substances from a chemical waste site, or through depletion of ozone layer, which may affect global warming. Environmental Chemistry explains the pollution of air, water, food and living organisms by toxic metals, soils, fossil fuels, pesticides and organic pollutants.

Heavy metals are defined as metallic elements that have a relatively high density compared to water. With the assumption that heaviness and toxicity are inter-related, heavy metals also include metalloids, such as arsenic, that are able to induce toxicity at low level of exposure. In recent years, there has been an increasing ecological and global public health concern associated with environmental contamination by these metals. Also, human exposure has risen dramatically as a result of an exponential increase of their use in several industrial, agricultural, domestic and technological applications. Environmental pollution is very prominent in point source areas such as mining, foundries and smelters, and other metal-based industrial operations.

Although heavy metals are naturally occurring elements that are found throughout the earth’s crust, most environmental contamination and human exposure result from anthropogenic (human) activities such as mining and smelting operations, industrial production and use, and domestic and agricultural uses of metals and metal-containing compounds. Environmental contamination can also occur through metal corrosion, atmospheric deposition, soil erosion of metal ions and leaching of heavy metals, sediment re-suspension and metal evaporation from water resources to soil and ground water. Natural phenomena such as weathering and volcanic eruptions also significantly contribute to heavy metal pollution. Industrial sources include metal processing in refineries, coal burning in power plants, petroleum combustion, nuclear power stations and high tension lines, plastics, textiles, microelectronics, wood preservation and paper processing plants.

In biological systems, heavy metals affect cellular organelles and components such as cell membrane, mitochondria, lysosomes, endoplasmic reticulum, nuclei, and some enzymes involved in metabolism, detoxification, and damage repair. Metal ions interact with cell components such as DNA and nuclear proteins, causing DNA damage and conformational changes that may lead to cell cycle modulation, carcinogenesis or apoptosis. Reactive oxygen species (ROS) production and oxidative stress play a key role in the toxicity and carcinogenicity of metals such as arsenic, cadmium, chromium, lead, and mercury. Because of their high degree of toxicity, these five elements rank among the priority metals that are of great public health significance. They are all systemic toxicants that are known to induce multiple organ damage, even at lower levels of exposure. The United States Environmental Protection Agency (U.S. EPA), and the International Agency for Research on Cancer (IARC), classify these metals as either “known” or “probable” human carcinogens based on epidemiological and experimental studies showing an association between exposure and cancer incidence in humans and animals.

Heavy metal-induced toxicity and carcinogenicity involve many mechanistic aspects, some of which are not clearly elucidated or understood. However, each metal is known to have unique features and physicochemical properties that confer to its specific toxicological mechanisms of action.

3.2 Why Study Environmental Chemistry

Environmental Chemistry is the study of chemical processes occurring in the environment which are impacted by humankind's activities. These impacts may be felt on a local scale, through the presence of urban air pollutants or toxic substances arising from a chemical waste site, or on a global scale, through depletion of stratospheric ozone or global warming. The focus in our courses and research activities is upon developing a fundamental understanding of the nature of these chemical processes, so that humankind's activities can be accurately evaluated.

Studying chemistry of the environment is therefore very important due to the challenges that we have in the environment. Most of Environmental Chemistry is socially important because it deals with the environmental impact of pollutants, the reduction of contamination and management of the environment. Environmental chemists study the behaviour of pollutants and their environmental effects on the air, water and soil environments, as well as their effects on human and animal health and the natural environment.

An environmental chemist may collect and analyse samples for identification of a contaminator, or help develop remediation programs. He or she may be involved in changing industrial practices so that the end result is a more environmentally-sound product. Some environmental chemists who work for industrial companies may advise employees on safety and emergency response, or on how to deal with government regulations and compliance issues.

The Environmental Chemistry emphasises and provides you with tools to:

(1) Understand the processes governing chemical transformation in soil, water and air.
(2) Analyse the key chemicals in the environment.
(3) Make meaningful predictions about the fates of these chemicals.

This emphasis draws on subjects outside of a classical chemistry degree programme to include courses in atmospheric science, soil microbiology, environmental toxicology and mineralogy.

3.3 Theoretical Background to the Study of Environmental Chemistry

Environmental Chemistry, as a course, provides theoretical tools and frameworks of an understanding chemistry of the environment. In the first place, it enables students to know more about hazards caused by improper use of chemicals in the environment. By the end of the study, you should be able to understand and participate intelligently in reducing the menace caused by chemical pollutants in the environment. As an enlightened person, you should be able to avoid some practices that expose our environment to such chemicals and also advice others when necessary. You should be able to recognise and articulate why these issues arise, how they affect your life and the lives of others around the world, what possible solutions are like, and what the consequences of not protecting the environment would be.

The environmental consequences of rapid industrialisation have resulted in countless incidents of land, air and water resources sites being contaminated with toxic materials and other pollutants, threatening humans and ecosystems with serious health risks and possibly death (Figure 1). More extensive and intensive use of materials and energy has created cumulative pressures on the quality of local, regional and global ecosystems.

Figure 1: Effect of Crude Oil Spill on Aquatic Animal

Before now, there was a concerted effort to restrict the impact of pollution; environmental management extended little beyond laissez-faire tolerance, tempered by disposal of wastes to avoid disruptive local nuisance conceived of in a short-term perspective. The need for remediation was recognised by exception, in instances where damage was determined to be unacceptable. As the pace of industrial activity intensified and the understanding of cumulative effects grew, a pollution control paradigm became the dominant approach to environmental management.

Two specific concepts served as the basis for the control approach:

1. The assimilative capacity concept, which asserts the existence of a specified level of emissions or release of toxic waste into the environment which does not lead to unacceptable environmental or human health effects
2. The principle of control concept, which assumes that environmental damage can be avoided by controlling the manner, time and rate at which pollutants enter the environment.

Under the pollution control approach, attempts to protect the environment have especially relied on isolating contaminants from the environment and using end-of-pipe filters and scrubbers. These solutions have tended to focus on media-specific environmental quality objectives or emission limits and have been primarily directed at point source discharges into specific environmental media (air, water, soil).

4.0 CONCLUSION

Environmental chemistry students would have learnt what environmental chemistry and its effect is. Our environment is exposed to various chemicals due to human activities and other natural processes. These chemicals have disastrous effect on our environment and invariably on the inhabitant of the place (living organisms). Therefore environmental chemistry is defined as the study of chemical processes occurring in the environment, which are caused by humankind's activities through natural processes.

5.0 SUMMARY

We have looked at environmental chemistry as it affects us from the broader perspective; it is basically the effect of the chemicals released into the environment as a result of our daily activities and natural processes. This environment is increasingly becoming un-conducive for us and other organisms that inhabit it.

6.0 TUTOR-MARKED AND ASSIGNMENT

1. If the environment is not well taken care of, humans and living organisms may go into extinction. Discuss.
2. What do understand by environmental chemistry?

7.0 REFERENCES/FURTHER READING

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UNIT 2 WHY STUDY ENVIRONMENTAL CHEMISTRY?

CONTENTS

1.0 INTRODUCTION

The intention of this unit is to make you understand the sources of Environmental Chemistry pollutants and the differences between them if any. Emphasis will be laid on the contribution of humans in polluting the environment with chemicals and the medium through which these environmental chemicals are dispersed to soil, air, water and food will be highlighted.

2.0 OBJECTIVES

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

- understand the sources of Environmental Chemistry pollutants
- describe the pathway through which these chemicals are dispersed
- list their effects on the environment
- list the remedy to the Environmental Chemistry pollutants.

3.0 MAIN CONTENT

3.1 Nature of Chemical Pollutants

Chemical pollution is defined as the presence or increase in our environment of chemical pollutants that are not naturally present there or are found in amounts higher than their natural background values. Most of the chemicals that pollute the environment are man-made, resulting from the various activities in which toxic chemicals are used for various purposes.

Chemical intoxications caused by exposure to chemical pollutants and can have immediate effects or delayed effects, which may appear after weeks or even months after the exposure occurred. Severe chemical intoxication may cause the death of the person that inhales an increased quantity of such substances. Chemical compounds are organic or inorganic chemicals that are the main causes of chemical pollution. The most common chemical pollutants are those compounds used across large areas and which are persistent, meaning they do not easily degrade in nature. Examples are most pesticides, herbicides, insecticides used in agriculture and gardening, as well as chlorinated solvents used in many industrial processes and dry-cleaning activities.

Based on their chemical structure, chemical contaminants can be classified into naturally-occurring and man-made. They can be organic or inorganic (organic compounds always contain carbon and carbon-hydrogen bonds, whereas most inorganic compounds do not contain carbon).

3.2 Sources of Chemical Pollutants

Chemical pollutants mostly result from various human activities like the manufacturing, handling, storage, and disposing of chemicals. These occur in industrial places and activities such as oil refineries, coal power plants, construction, mining & smelting, transportation, agricultural use of pesticides and insecticides, as well as household activities. The chemical industry is another example in this sense, mainly because it is usually linked to polluted waste streams (Figure 2). In fact, the waste streams from chemical industry are now strictly controlled and treated before being released into the environment. But this was not always the case in the past and many rivers and surface water bodies were contaminated by the numerous waste streams coming from various chemical plants, as well as other industrial sources. Even though measures were taken to reduce this type of pollution, the effects are still visible.

Household chemicals involve a variety of chemical products and mixtures that can easily become chemical pollutants when released into the environment. Even the everyday detergents are chemical compounds that may pollute our environment! Read the labels of detergent products to confirm that they contain a variety of potentially hazardous chemicals.

Figure 2: Source of Water Pollution from Industrial Effluent

3.3 Other Sources of Pollution

Domestic sources of pollution include toilets, latrines and wastewater from kitchens and bathrooms. If these wastes are properly contained and prevented from getting into the environment, they will not cause pollution. However, frequently this is not the case. Open defecation obviously releases human waste into the environment, which can then be washed into rivers and other surface waters. Solid wastes from households and also from shops, markets and businesses include food waste, packaging materials and other forms of rubbish. Domestic sources are also responsible for gaseous pollutants in the form of smoke and carbon dioxide from domestic fires.

3.4 Dispersal Pathways of Pollutants

Pollution always has a source and a recipient. The pathway of pollution is the way the pollutant moves from the source, enters into the environment, and finally reaches the human body or other recipients. The pathway between source and recipient can take several different forms depending on the type of pollutant. Primary recipients for pollution are water, air, and soil. Pollutants usually reach humans through the consumption of contaminated and polluted water and food, and breathing polluted air. Once released into the environment, the worst effects of many pollutants are reduced by one or more of the following processes:

- Dispersion – smoke disperses into the air and is no longer noticeable away from the source.
- Dilution – soluble pollutants are diluted in water of a river or lake.
- Deposition – some suspended solids carried in a river settle (are deposited) on the river bed.
- Degradation – some substances break down (degrade) by natural processes into different, simpler substances that are not polluting.

In each case the effect is to reduce the concentration of the pollutant. Concentrations a measure of the amount of the substance in a known volume of water or air. The units used for water pollutants are usually milligrams per litre (mg/l, also), although sometimes you may see the unit scale as ppm which stands for ‘parts per million’. These processes do not apply to all pollutants. There are some persistent pollutants which remain intact when released into the environment because they do not break down by natural processes.

3.5 Effects of Chemical Pollution

Chemicals and pesticides are used in our agricultural processes. To protect our crops, we spray them with pesticides. To ensure the health of livestock, commercial farmers spray chemicals on the pens. Excessive use of fertilizers is another source of water pollution. All of these can seep into the ground and contaminate our soil, and eventually, these chemicals will make it into our water supply system, water bodies and the food we eat. These toxic elements find their way into our atmosphere too, and add to the degradation of our environment.

Emissions from the vehicles used on daily bases contribute to air pollution. Cars, planes, and other conveyances give off carbon dioxide as they burn fossil fuel in the form of petroleum. The large amount of CO_2 emitted by the millions of vehicles in the world today contributes to global warming. Ships also cause chemical pollution, especially those that carry crude oil. There have been several incidents of oil spills which caused some serious damages to living organisms in the environment. We still don’t know the long term effects of this amount of pollution in the ocean. One thing for sure is that it’s contaminating one of our major food sources which is seafood.

Chemical pollution can be caused by a variety of chemicals from a variety of sources and can involve a variety of health effects from simple digestive problems to chemical intoxication and sudden death by poisoning (Figure 3). The effects are usually related to the exposure to high amounts of chemicals. Chemical pollution leads to various serious diseases, generally by consuming poisonous food, drinking highly contaminated water, or breathing highly contaminated air.

Figure 3: Moribund Fishes in Polluted Water

Various chemical pollutants may accumulate in aquatic sediments over longer period of time. This means that, if no tests are performed, chemical pollution in the ocean water could pose serious health risks to the ecosystem and ultimately could cause mild or deadly chemical intoxication in humans after the consumption of contaminated fish or seafood. Aquatic biotas not only degrade chemical pollutants but also may accumulate them in their cells, organs, or other tissues. When aquatic organisms accumulate chemicals only from the water, the process is called *bio concentration*; when they accumulate chemicals from both water and food, the process is called *bio-accumulation*. In surface waters, bio-concentration and bio-accumulation are of particular concern in aquatic organisms that are high on the food chain and that may be ingested by humans or by other organisms, such as birds or bears. One example of the detrimental effects of bioaccumulation is the occurrence of elevated blood levels of highly toxic methylmercury among certain indigenous peoples of Canada.

One route of exposure is thought to originate with the damming of rivers for hydroelectric development, resulting in release of mercury (Hg) from flooded soils. Biotransformation, mainly by sulfate-reducing bacteria, converts inorganic Hg into highly toxic methyl mercury (CH_3Hg^+), which bio-accumulates in fish that are subsequently consumed by people. Another notorious example of the effects of bio-accumulation is the near-extinction of many birds of prey due to their bio-accumulation of the pesticide DDT and its metabolites. DDT was introduced during WWII to combat disease-carrying mosquitoes in the Pacific theater, and subsequently was used extensively in the United States and other parts of the world to suppress mosquito populations. DDT and its metabolites accumulated in fish, which were then consumed by birds of prey, causing the birds' egg shells to prematurely break and thereby causing reproductive failure. Chemical intoxication can have severe health effects that may trigger immediate symptoms and diseases or delayed effects which may appear after weeks or months since the exposure occurred. This is based on the type of pollutants and on the amounts to which you are exposed.

4.0 CONCLUSION

Chemical pollutants in the environment have different sources that require media for their dispersal to soil, air, water and food. Humans play a critical role in destroying their environment through improper utilisation and disposal of these hazardous chemicals in the environment.

5.0 SUMMARY

Students of Environmental Health have comprehensively learnt the sources where chemical pollutants originate and the media through which they are dispersed to soil, air, water and food.

6.0 TUTOR-MARKED ASSIGMENT

1. Discuss the role of human in destroying his environment.
2. Explain the media through which chemical pollutants are dispersed.

7.0 REFERENCES/FURTHER READING

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UNIT 3 REMEDY TO CHEMICAL IN THE ENVIRONMENT

CONTENTS

1.0 INTRODUCTION

Having examined Environmental Chemistry in relation to the sources of chemical pollutants that is bedeviling the environment, it is also paramount to look at the remedy to the effect of pollutants in the environment. In this unit, we will be looking at the possible control measures of chemical pollutants that affect environments.

2.0 OBJECTIVES

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

- know control measure of chemical pollutants in the environment
- apply control measure on chemical pollutants
- advocate for the sustenance of a safer environment and prevent environmental pollution.

3.0 MAIN CONTENT

3.1 Highlight of Environmental Pollutants

Industrial wastes:- Disposal of industrial wastes is the major problem of soil pollution. Sources of industrial pollutants are mainly discharged from various sources such as pulp and paper mills, chemical fertilizers, oil refineries, sugar factories, tanneries, textiles, steel, distilleries, fertilizers, pesticides, coal and mineral mining industries, drugs, glass, cement, petroleum and engineering industries, etc.

Effect:- These pollutants affect and alter the chemical and biological properties of soil. As a result, hazardous chemicals can enter into human food chain from the soil or water, disturb the biochemical process and finally lead to serious effects on living organisms.

Urban wastes:- Urban wastes comprise of both commercial and domestic wastes consisting of dried sludge and sewage. All the urban solid wastes are commonly referred to as refuse. Constituents of urban refuse consists of garbage and rubbish materials like plastics, glasses, metallic cans, fibres, paper, rubbers, street sweepings, fuel residues, leaves, containers, abandoned vehicles and other discarded manufactured products. Urban domestic wastes though disposed of separately from industrial wastes, can still be dangerous. This happens because they are not easily degraded.

Agricultural practices:- Modern agricultural practices pollute the soil to a large extent. With the advancing agro-technology, huge quantities of fertilizers, pesticides, herbicides and weedicides are added to increase the crop yield. Apart from these farm wastes, manure, slurry, debris, soil erosion containing mostly inorganic chemicals are reported to cause soil pollution.

Radioactive pollutants:- Radioactive substances resulting from explosions of nuclear testing laboratories and industries giving rise to nuclear dust radioactive wastes, penetrate the soil and accumulate giving rise to land/soil pollution.

3.2 Remedy to Environmental Waste

Proper dumping of unwanted materials:-Excess wastes by humans and animals pose a disposal problem. Open dumping is the most commonly practiced method. Nowadays, controlled tipping is followed for solid waste disposal. The surface of the waste so obtained is used for housing or sports field. Production of natural fertilizers:- Bio-pesticides should be used in place of toxic chemical pesticides. Organic fertilisers should be used in place of synthesised chemical fertilisers. Example: Organic wastes in animal dung may be used to prepare compost manure instead of throwing them wastefully and polluting the soil.

Public awareness:- Informal and formal public awareness programs should be imparted to educate people on the health hazards caused by environmental pollution. Mass media, Educational institutions and voluntary agencies can achieve this.

Recycling and reuse of wastes:- To minimise soil pollution, wastes such as paper, plastics, metals, glasses, organics, petroleum products and industrial effluents etc should be recycled and reused. Industrial wastes should be properly treated at source. Integrated waste treatment methods should be adopted.

Ban on toxic chemicals:- A ban should be imposed on chemicals and pesticides like DDT, BHC, etc., which are fatal to plants and animals. Nuclear explosions and improper disposal of radioactive wastes should also be banned.

Pollutants, such as, lead; suphuric acid, etc. are harmful to human beings, animals and cause damage to the environment. Trade practitioners should arrange licensed waste collectors to collect and deliver waste batteries to approved facilities for treatment.

Other remedies include:

- Chemical waste should be stored at designated areas having walls or partitions and with impermeable floors or surfaces, which do not react chemically with the waste or in purposely-built chemical waste storage cupboard.
- There should not be any connection to surface water drains or foul sewers.
- No rainwater or waste water should be allowed to flow into or accumulate in storage areas.
- Chemical waste storage areas should display a hazard warning sign, panel, notice or marking.
- The sign, panel, notice or marking should indicate in bold legible characters not less than 6 cm in height on a white background.
- Containers for chemical wastes should be properly labeled.
- Promptly arrange delivery of chemical wastes away from storage areas to avoid accidents

The goal of air-pollution control (APC) is to limit the amount of pollutants entering the environment. These include particulate matter (PM), acid gases, greenhouse gases, organic vapors such as hazardous air pollutants (HAPs), volatile organic compounds (VOCs), non-condensed gases (NCGs), aerosols, dioxins, oxides of nitrogen (NOx), metals and others.

4.0 CONCLUSION

In this unit, the remedy to environmental chemical pollutants and some domestic wastes were highlighted. These chemicals disposed in large quantities to the surrounding, not remedied properly can cause environmental challenges such as disease outbreak, pollution of water, land, and atmosphere.

5.0 SUMMARY

Some chemical pollutants in the environment were highlighted. Sources of pollutants include industrial wastes, urban wastes, improper agricultural practices and radioactive wastes. Chemical pollutants can be controlled through proper disposal of wastes. Some remedies such as proper dumping of unwanted materials, production of natural fertilizers, public awareness, recycling and re-use of wastes as well as ban on toxic chemicals were outlined in this unit.

6.0 TUTOR-MARK ASSIGMENT

1. Discuss the solution to the incessant waste disposal in our environment.
2. What are the most common chemical pollutants that are affecting our environment?

7.0 REFERENCES/FURTHER READING

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MODULE 2 TECHNIQUES IN PARASITOLOGY, MICROBIOLOGY AND EFFECT OF RADIATION EXPOSURE

UNIT 1 TECHNIQUES IN MICROBIOLOGY

CONTENTS

1.0 INTRODUCTION

Microorganisms are well known in causing a familiar range of diseases in animals and plants and problems in food spoilage and deterioration of other materials; microbes are also our ‘invisible allies’. Indeed, life on earth would not be sustainable without the benefits that many of them provide. The teaching of such an important subject as microbiology cannot be achieved effectively without enhancing the theory with ‘hands on’ experience in the concepts of microbiology. The purpose of this unit is to enlighten you with good techniques in microbiology and ensure that understanding of microbes proceeds in the right direction and achieves the required educational aims, successfully.

2.0 OBJECTIVES

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

- describe the techniques in studying microbes
- explain the pathogenic and non-pathogenic microbes
- understand some methods used in handling pathogenic microbes
- know the safety precautions used when handling microbes.

3.0 MAIN CONTENT

3.1 Microbiological Concept

Microbiology is the branch of biology that is concerned with the study of microorganisms, or life too little to be seen with the naked eyes. They include bacteria, viruses, fungi, and pathogenic protozoan/parasites, but not limited to studies of infectious disease-causing microorganisms. Microbiological organisms such as bacteria, viruses, protozoan and parasites are single celled with nucleus. Microbiology is sub-divided into divisions including bacteriology, virology, mycology, parasitology and others. Parasitology will be considered in another unit. A scientist who specialises in the area of microbiology is called a microbiologist.

3.1.1 Bacteriology

Bacteria are single-celled microorganisms that lack a nuclear membrane, are metabolically active and divide by binary fission. Medically, they are major cause of diseases. Superficially, bacteria appear to be relatively simple forms of life; in fact, they are sophisticated and highly adaptable. Many bacteria multiply at rapid rates, and different species can utilize an enormous variety of hydrocarbon substrates, including phenol, rubber, and petroleum. These organisms exist widely in both parasitic and free-living forms. Because they are ubiquitous and have a remarkable capacity to adapt to changing environments by selection of spontaneous mutants, the importance of bacteria in every field of medicine cannot be overstated.

Most diseases now known to have a bacteriologic etiology have been recognised for hundreds of years. Some were described as contagious in the writings of the ancient Chinese, centuries prior to the first descriptions of bacteria by Anton van Leeuwenhoek in 1677. There remain a few diseases (such as chronic ulcerative colitis) that are thought by some investigators to be caused by bacteria but for which no pathogen has been identified. Occasionally, some previously unrecognized diseases are associated with a new group of bacteria. An example is Legionnaire's disease, an acute respiratory infection caused by the previously unrecognised genus, *Legionella*. Also, a newly recognised pathogen, *Helicobacter*, plays an important role in peptic disease. Another important example, in understanding the etiologies of venereal diseases, was the association of at least 50 percent of the cases of urethritis in male patients with *Ureaplasmaurealyticum* or *Chlamydia trachomatis.*

3.1.2 Classification

A few different criteria are used to classify bacteria. They can be distinguished by the nature of their cell walls, by their shape, or by differences in their genetic makeup. The stains a test used to identify bacteria by the composition of their cell walls. It is named after Hans Christian Gram, who developed the technique in 1884. Bacteria are first stained with a purple dye called crystal violet, which specifically binds to peptidoglycan, a complex structure of amino acids and sugars found in the cell wall. This is followed by a series of steps that ultimately remove any unbound or loosely bound crystal violet as further described below.

Then the cells are stained with a second red-colored dye called safranin. Gram-positive bacteria stain purple because their cell walls are rich in peptidoglycan. On the other hand, Gram-negative bacteria whose cells walls have two layers take on a red coloring. The outer layer of lipids does not bind strongly to crystal violet and the dye is easily washed away during the staining process. For example, *Streptococcus pneumoniae*, which causes pneumonia, is a Gram-positive bacterium, while *Escherichia coli*(*E.coli*) and *Vibrio cholerae*, which causes cholera, are Gram-negative bacteria.

There are three basic bacterial shapes. The round-shaped bacteria are referred to as cocci (singular: coccus); cylindrical/capsule-shaped bacteria as bacilli (singular: bacillus); and spiral bacteria are aptly called spirilla (singular: spirillum). Cocci can alsoassociate with one anotherin different configurations: a combination of two is referred to as diplococcus; a linear chain as streptococcus; and a cluster as staphylococcus. The shapes and configurations of bacteria are often reflected in their names. For example, the milk-curdling *Lactobacillus acidophilus*is bacilli, and pneumonia-causing *Streptococcus pneumonia* are a chain of cocci.

The classification criteria mentioned thus far are based on physiological properties and morphology. However, classification of bacteria based on their evolutionary relationships to one another, that is to say, drawing a sort of family tree of all bacterial species, is a relatively new development. This type of phylogenetic classification became possible with the advent of nucleotide sequencing technology (the ability to read the order of nucleotides in DNA or RNA). Since ribosomes are present in all living organisms, one can look at similarities and differences in the RNA sequences that encode certain ribosomal proteins and determine the degree of relatedness of different organisms.

3.1.3 Virology

A virus is a small infectious organism which is much smaller than a fungus or bacterium that must invade a living cell to reproduce (replicate). The virus attaches to a cell (called the host cell), enters the cell, and releases its DNA or RNA inside the cell. The virus's DNA or RNA is the genetic material containing the information needed to make copies of (replicate) the virus. The virus's genetic material takes control of the cell and forces it to replicate the virus. The infected cell usually dies because the virus keeps it from performing its normal functions. When it dies, the cell releases new viruses, which go on to infect other cells.

Viruses are classified as DNA viruses or RNA viruses, depending on whether they use DNA or RNA to replicate. RNA viruses include retroviruses, such as HIV (Human Immunodeficiency Virus). RNA viruses, particularly retroviruses, are prone to mutate. Some viruses do not kill the cells they infect but instead alter the cell's functions. Sometimes the infected cell loses control over normal cell division and becomes cancerous. While other viruses, such as hepatitis B virus and hepatitis C virus, can cause chronic infections. Chronic hepatitis can last for years, even decades. In many people, chronic hepatitis is quite mild and causes little liver damage. However, in some people, it eventually results in cirrhosis(severe scarring of the liver), liver failure, and sometimes liver cancer.

3.1.4 Fungi

The word fungus usually evokes images of mushrooms and toadstools. Although mushrooms are fungi, the forms that a fungus may take are varied. There are over 100,000 species of described fungi and probably over 200,000 that are not described. *Candida* species are important human pathogens that are best known for causing opportunist fungal infections in immune-compromised hosts (e.g. transplant patients, AIDS sufferers, cancer patients). Infections are difficult to treat and can be very serious: 30-40% of systemic infections result in death. The sequencing of the genome of *C. albicans* and those of several other medically-relevant *Candida* species have provided a major impetus for *Candida* comparative and functional genomic analyses. These have provided a fascinating insight into the molecular and cellular biology of these fungi and these should pave the way for the development of more sensitive diagnostic strategies and novel antifungal therapies.

Most fungi are terrestrial, but they can be found in every habitat worldwide, including marine (500 spp.) and freshwater environments. Fungi are non-motile, filamentous eukaryotes that lack plastids and photosynthetic pigments. The majority of fungi are saprophytes; they obtain nutrients from dead organic matter. Other fungi survive as parasitic decomposers, absorbing their food, in solution, through their cell walls. Most fungi live on the substrate upon which they feed. Numerous hyphae penetrate the wood, cheese, soil, or flesh in which they are growing. The hyphae secrete digestive enzymes that break down the substrate, enabling the fungus to absorb the nutrients contained within the substrate. There are four major groups of fungi: Zygomycota, Ascomycota (sac fungi), Basidiomycota (club fungi), and Deuteromycota (fungi imperfecti).

The fungal group Zygomycota is most frequently encountered as common bread molds, although both freshwater and marine species exist. Most of these live on decaying plant and animal matter found on the substrate. Aquatic species are primarily found in sediments or on algae, but some species are also free floating. A few are found attached to aquatic animals or on decaying leaves. Some are parasites of plants, insects, or small soil animals, while others cause serious infections in humans and domestic animals.

The Ascomycota comprise about 30,000 described species, among them most of the blue-green, red, and brown molds that cause food spoilage, including the salmon-colored bread mold. Ascomycetes are the cause of a number of serious plant diseases, like Dutch elm disease, but the group also includes edible morels and truffles. This group is also comprised of the yeasts used in the production of beer, wine and bread. With the exception of unicellular yeasts, the Ascomycetes are filamentous during development and their hyphae are septate (divided into cells).

The fungal group Basidiomycota, also known as the club fungi, includes some of the most familiar fungi. Within this group of 16,000 species are the mushrooms, toadstools, shelf fungi, and puffballs. Basidiomycetes play a key role in the environment as decomposers of plant litter. They are distinguished from other fungi by their production of basidio spores, which are borne outside a club-shaped, spore-producing structure called a basidium. This group is poorly represented in the aquatic environment. There are very few species of freshwater species known and the majority of marine species are free-floating with a couple of lignicolous (found on wood) species.

The Deuteromycota, or conidial fungi, are a group of about 17,000 distinct species in which the sexual reproductive features are either not known or are not used to classify them. Their lack of sexual stages was the basis for them being called fungi imperfecti in the past. The term fungi imperfecti was misleading because these fungi are abundant and flourishing. Most Deuteromycota have only asexual reproduction as the sexual stage of the life cycle has been lost or has yet to be discovered. There are a great number of human uses for these fungi; most significant is the production of antibiotics for medicinal use. These substances are produced by the fungus to inhibit the growth of other living organisms around them - in particular, disease-causing bacteria. These substances are extracted from the fungus and are used to kill bacteria in the human body

3.2 Handling of Microbes

Culturingis the term used to describe growing microbes, usually combined with tests to see what the microbes like to eat or what conditions they can live in. If you've ever seen a petri dish, you've seen a common place where microbes are cultivated.

3.2.1 Maintaining Stock Cultures

It may be convenient to maintain a stock of a pure culture instead of re-purchasing it when needed. Most of those considered suitable for use are also relatively easy to maintain by sub-culturing on the medium appropriate for growth but maintenance of stock cultures needs to be well organised with attention to detail. Be prepared to transfer cultures four times a year to maintain viability. Cultures on streaked plates are not suitable as stock cultures. Slope cultures in screw cap bottles are preferred because the screw cap reduces evaporation and drying out and cannot be accidentally knocked off. Slope cultures are preferred to broth (i.e. liquid medium) cultures because the first sign of contamination is much more readily noticed on an agar surface. Two stock cultures should be prepared; one is the 'working' stock for taking sub-cultures for classes, the other is the 'permanent' stock which is opened only once for preparing the next two stock cultures. Incubate at an appropriate temperature until there is good growth. For growing strict aerobes, it may be necessary to slightly loosen the cap for incubation (but close securely before storage) if there is insufficient air in the headspace. As soon as there is adequate growth, the cultures may be stored in a refrigerator, but never one in which human foodstuffs are kept. However, they will remain viable at room temperature in either a cupboard or drawer. Be on the lookout for contamination (Figure 4) below.

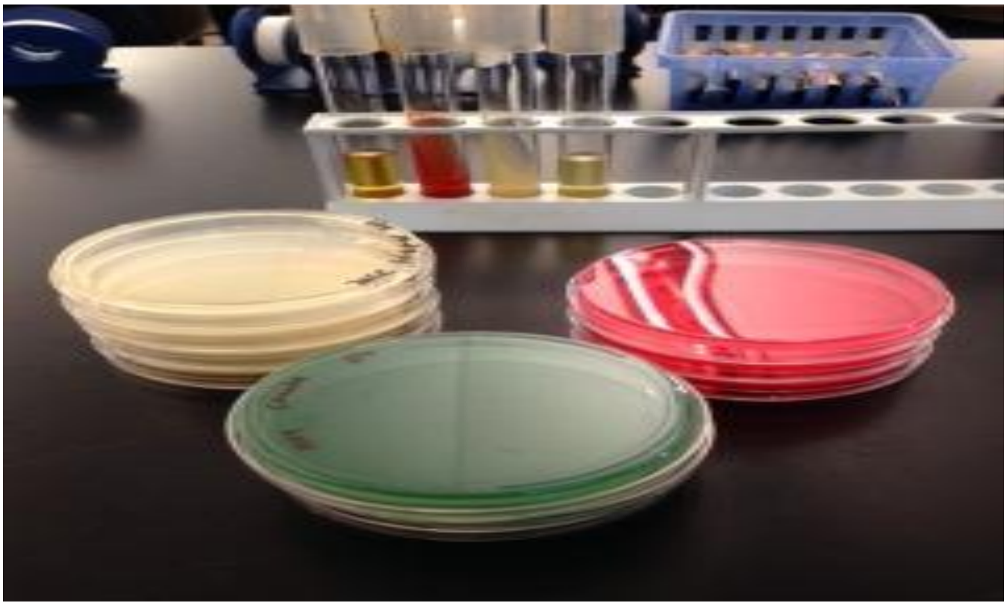

Figure 4: Different types of culturing methods

3.2.2 Preventing Contamination of Cultures and the Environment

Cotton wool plugs made of non-absorbent cotton wool are used in test tubes and pipettes to prevent micro-organisms from passing in or out and contaminating either the culture or the environment. The necessary movements of air in and gaseous products out are not prevented and the gaps between the cotton wool fibre are even and wide enough for micro-organisms to pass through. However, this does not happen because micro-organisms (negatively charged) are ‘filtered’ out by being attracted to and adsorbed on the oppositely charged cotton wool. The cotton wool must remain dry because this filtration property is lost if the cotton wool becomes moist – hence the use of non-absorbent cotton wool. For use in test tubes a plug should be properly made to ensure that it can be held comfortably without being dropped and its shape and form are retained while being removed from and returned to a test tube several times. Aseptic technique cannot be maintained with poorly made plugs; working surfaces, floors and cultures may become contaminated and students may become understandably (but avoidably) frustrated and lose interest.

3.3 Microscopic Examination of Microorganisms

The setting up of a microscope is a basic skill of microbiology, yet it is rarely mastered. Only when it is done properly can the smaller end of the diversity of life be fully appreciated and its many uses in practical microbiology, from aiding identification to checking for contamination, be successfully accomplished. The level of magnification to which a microscope can project is an important feature but it is the resolving power that determines the amount of detail that can be viewed.

3.3.1 Bacteria and Yeast

Yeast can be seen in unstained wet mounts at magnification of ×100. Bacteria are much smaller and can be seen unstained at ×400 but only if the microscope is properly set up and all that is of interest is whether or not the microorganisms motile. A magnification of ×1000 and the use of an oil immersion objective lens for observing stained preparations are necessary for viewing their characteristic shapes and arrangements. The information gained, along with descriptions of colonies, is the starting point for identification of genera and species, but further work involving physiology, biochemistry and molecular biology is then needed.

3.3.2 Moulds

Routine identification of moulds is based entirely on the appearance of colonies to the naked eye and of the mycelium and spores in microscopical preparations. Mould mycelia and spores can be observed in unstained wet mounts at magnification of ×100.Although direct observations of ‘mouldy’ material through the lid of a Petri dish or specimen jar at lower magnifications with the plate microscope are also informative (but keep the lid on).Routine identification of moulds is based entirely on the appearance of colonies to the naked eye and of the mycelium and spores in microscopical preparations.

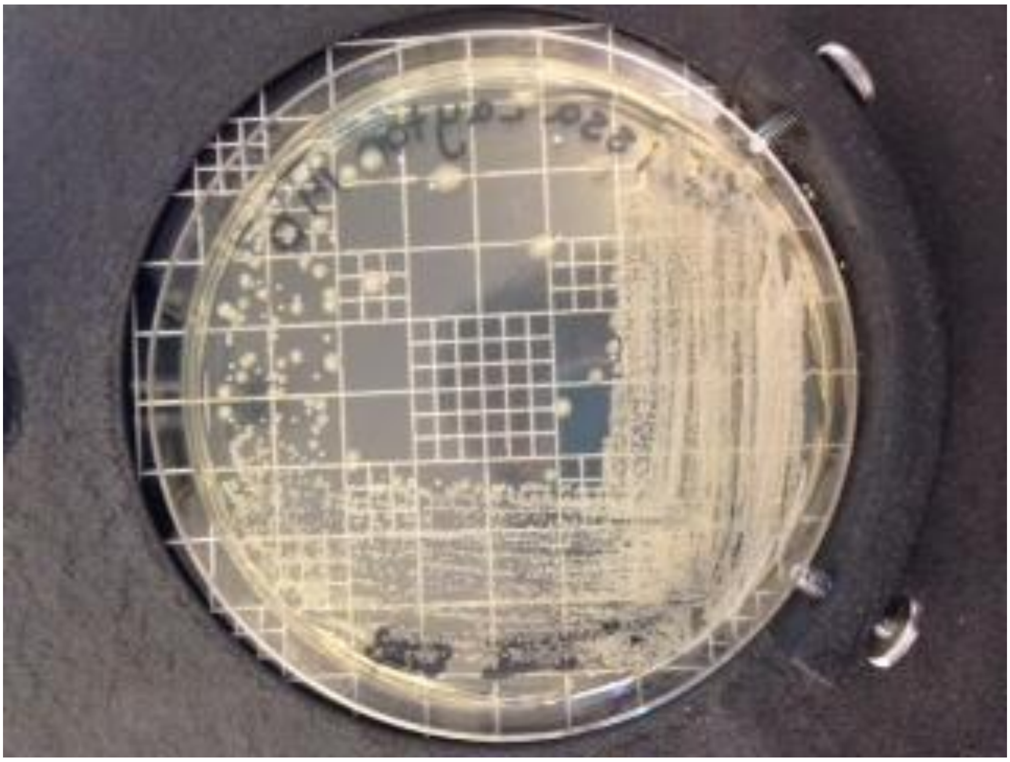

Figure 5: Colonies on an Agar Plate

3.3.3 Protozoa and Algae

Protozoans and algae are large organisms and therefore are readily visible at a magnification of ×10 to ×100 in unstained wet mounts. A magnification of ×100 is advantageous for observing natural samples that contain a variety of organisms, particularly as many are very motile. Identification of algae and protozoans is based entirely on their microscopic appearance. The common algae are green and non-motile; diatoms have a brown, sculptured outer layer of silica and move slowly. Protozoans are colourless and most are motile.

3.4 General Safety Considerations

The nature of the growth, reproductive capacity and biochemistry of many micro-organisms makes them of great economic, social and medical importance. The fundamental rules of personal, public and domestic hygiene rely on an understanding of the characteristics of these organisms. Micro-organisms possess many obliging features that make them ideal subjects for safe practical exercises in schools. Unlike many organisms, they do not necessarily have to be maintained over long periods and do not have to be fed and watered at weekends. The detailed guidance to minimise risk for each is provided below.

Level 1 (L1): work with organisms which have little, if any, known risk and which can be carried out by teachers with no specialist training. The organisms will be observed in the closed containers in which they were grown.

Level 2 (L2): work where there may be some risks of growing harmful microbes but these are minimised by a careful choice of organisms or sources of organisms and by culturing in closed containers which are taped before examination and remain unopened unless the cultures within have been killed. Once a culture, prepared by students, has been grown, sub-culturing or transfer of organisms from one medium to another is not normally done.

Level 3 (L3): work where cultures of known fungi and bacteria are regularly sub-cultured or transferred. This work is normally confined to students over the age of 16 and institutions where facilities are appropriate. Teachers should be thoroughly trained and skilled in aseptic technique. This is a higher level of training than required for L2 work. Non-specialist teachers should not carry out or supervise this work.

4.0 CONCLUSION

In nature, microbes are found everywhere in which some are pathogenic, while others are not harmful. Studying microbes prepares us with the knowledge of how to handle them in the laboratory.

5.0 SUMMARY

In this unit, we have discussed concepts of microbiology, by highlighting pathogenic and non-pathogenic microoganisms. Ones and also, The roles played by some common bacteria, viruses, fungi were explained way of culturing microbes and precautions on how to handle them.. The lessons learnt in this unit should equip students properly on microbiological techniques.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain why maintaining stock culture is important in microbiological techniques.
2. Why are microorganisms considered beneficial to humans?

7.0 REFERENCES/FURTHER READING

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UNIT 2 TECHNIQUES IN PARASITOLOGY

CONTENTS

1.0 INTRODUCTION

Parasitology, traditionally, has includes the study of three major groups of animals: parasitic protozoans, parasitic helminths (worms), and those arthropods that directly cause disease or act as vectors of various pathogens. A parasite is a pathogen that simultaneously injures and derives sustenance from its host. Some organisms called parasites are actually commensals, in that they neither benefit nor harm their host (for example, *Entamoeba coli*). Although parasitology had its origins in the zoological sciences, it is today an interdisciplinary field, greatly influenced by microbiology, immunology, biochemistry and other life sciences.

2.0 OBJECTIVES

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

- explain the Parasitological terms
- list parasites and their hosts
- explain host-parasites relationship.

3.0 MAIN CONTENT

3.1 Procedures in Parasitology

Parasitology is the branch of biology that studies parasites, their characteristics (morphology, molecular, genetic and evolutionary), their way of life (reproduction, life cycle and relationship with their hosts) and diseases, or infections caused by them (epidemiology, geographic distribution, transmission and detection techniques and disposal). Parasitology is divided into vegetal parasitology and animal parasitology, which are the study of parasites and parasitic diseases of plants and animals, respectively. In turn, animal parasitology is divided in human parasitology and veterinary parasitology.

In strict sense, parasitology is the study of protozoan parasites (e.g. *Leismania*sp.), helminths (e.g. *Ascaris*sp.) and arthropods (e.g. fleas). Thus, it includes three branches of zoology: protozoloogy, helminthology and arthropodology.Parasites have a great diversity in morphology. Sizes can range from a few micrometers (*Trypanosoma*sp.) to more than a dozen meters (*Taenia*sp.). They can take different forms during their life cycle, be found inside or outside of the host cells (intracellular or free) and, in some cases, they can form cysts when conditions are not favourable.

Nomenclature and systematics of parasites have evolved a lot over the last few years; they are based now not only in morphology but also in genetic and immunological features.Parasitology also deals with the study of the epidemiology of diseases caused by parasites.

In this study, the following factors are important:

- ✓ The existence of a reservoir host: i.e. human being or animal that carries the parasite (e.g. the *Anopheles*mosquito, which transmits the etiologic agent of malaria, a protozoan of the genus *Plasmodium*);
- ✓ The presence of vector(s) (intermediate host(s);
- ✓ Geographical conditions (presence of the parasite and the host in the same territory, population density, etc.);
- ✓ Climatic conditions (Temperature, humidity, etc.);
- ✓ Ethological conditions (socio cultural behaviour, hygiene habits, economic conditions, etc.)
- ✓ Host resistance (conditioned by age, genetics, immunity, presence of other diseases, etc.).

3.2 Host Parasite Interactions

Based on the nature of the host-parasite interactions and environmental factors, the parasite may be one of the following types:

- ✓ An obligatory parasite that is completely dependent on its host and can't survive without it e.g. hookworms.
- ✓ A facultative parasite that can change its life style between free-living in the environment and being parasitic according to the prevailing conditions. e.g. *Strongyloidesstercoralis*.
- ✓ An accidental parasite that affects an unusual host e.g. *Toxocaracanis* (a dog parasite) in human.
- ✓ A temporary parasite that visits the host only for feeding and then leaves it. e.g. Bed bug visiting human for a blood meal.
- ✓ A permanent parasite that lives in or on its host without leaving it e.g. Lice.
- ✓ An opportunistic parasite that is capable of producing disease in an immune deficient host (like AIDS and cancer patients). In the immuno-competent host, it is either found in a latent form or causes a self-limiting disease e.g. *Toxoplasmagondii*.
- ✓ A zoonotic parasite that primarily infects animals and is transmittable to humans. e.g. *Fasciola* species.
- ✓ Hosts are classified according to their roles in the life cycles of parasites as:
- ✓ Definitive host (DH) harbours the adult or sexually mature stages of the parasite (or in whom sexual reproduction occurs) e.g. human is the DH for *Schistosomahaematobium*, while female *Anopheles* mosquito is DH for *Plasmodium* species (malaria parasites).
- ✓ Intermediate host (IH) harbours larval or sexually immature stages of the parasite (or in whom asexual reproduction occurs) e.g. human is IH of malaria parasites. Two intermediate hosts termed 1stand 2ndIH may be needed for completion of a parasite's life cycle, e.g. *Pirenellaconica* snail is the 1stIH, while *Tilapia* (Bolty) fish is the 2ndIH for *Heterophyesheterophyes*.
- ✓ Reservoir host (RH) harbours the same species and same stages of the parasite as human. It maintains the life cycle of the parasite in nature and is therefore, a reservoir source of infection for human. e.g. sheep are RH for *Fasciola hepatica*.
- ✓ Paratenic or transport host in whom the parasite does not undergo any development but remains alive and infective to another host. Paratenic hosts bridge the gap between the intermediate and definitive hosts. For example, dogs and pigs may carry hookworm eggs from one place to another, but the eggs do not hatch or pass through any development in these animals.
- ✓ Vector is an arthropod that transmits parasites from one host to another, e.g. female sand fly transmits *Leishmania* parasites.

Host-Parasite Relationship: The term refers to the relationship between a host and a parasite and the competition for supremacy that takes place between them. Disease should not be confused with infection as a person may be infected without becoming diseased. If the host has upper hand due to increased host resistance, the host remains healthy and the parasite is either destroyed or assumes a benign relationship with the host, but if the host loses the competition, a disease develops. In biology, the relationship between two organisms is mainly in the form of symbiosis, defined as "life together", i.e., the two organisms live in an association with one another. Thus, there are at least three types of relationships based on whether the symbiont has beneficial, harmful, or no effects on the other.

The various types of symbiotic association include:

- ✓ Mutualism is a relationship in which both partners benefit from the association. Mutualism is usually obligatory, since in most cases physiological dependence has evolved to such a degree that one mutual cannot survive without the other. Blood-sucking leeches cannot digest blood, and overcome this by harbouring certain intestinal bacterial species to do the digestion for them. At least 20% of insect species, as well as many mites, spiders, crustaceans and nematodes, mutually coexist with bacteria of the genus *Wolbachia*. Also, filarial nematodes such as *Wuchereriabancrofti* and *Onchocercavolvulus,* which cause serious human diseases, mutually with *Wolbachia*.Treating patients with antibiotics can cured bacterial infections as well as worms.
- ✓ Commensalism: This is a condition in which one partner benefits from the association, but the host is neither helped nor harmed. Commensalism may be facultative, in the sense that the commensal may not be required to participate in an association to survive. Humans harbour several species of commensal protozoans, thatcolonise in the intestinal tract such as *Entamoebadispar, E.hartmanni, E.moshkovskii, E. polecki, Endolimaxnana, Iodomoebabutschlii*.
- ✓ Parasitism: This is a situation in which one of the participants, the parasite, either harms or lives at the expense of the host. Parasites may cause mechanical injury, such as boring a hole into the host or digging into its skin or other tissues, stimulate a damaging inflammatory or immune response. Most parasites inflict a combination of these conditions on their hosts. Parasites are different from predators and parasitoids (which also derive benefits from certain interspecific interactions while harming the other participant) in that the host of a parasite is not necessarily killed. Instead, parasites derive benefits from their hosts, most often nutritional resources and shelter, over a longer period of time. It is in fact advantageous to parasites if they do not harm their hosts too badly, because that prolongs the period during which parasites can obtain benefits from hosts. However, in some cases, the impact of parasites on a host is great enough to cause disease, and in extreme cases, the death of the host may also occur (Yeh, 2002).

3.3 Classification and General Characters of Human Parasites

The classification of parasites is controversial as there is no universally accepted system. Parasites form part of the animal kingdom which comprises about 800,000 identified species categorized into 33 phyla. The most acceptable taxonomic classification of human parasites includes Endoparasites and Ectoparasites. Endoparasites are sub-classified into Helminthic parasites (multicellular organisms) and

Protozoan parasites (unicellular organisms). Helminthic parasites are either flat worms (Trematodes), segmented ribbon/tape - like worms (Cestodes), or cylindrical/round worms (Nematodes).

3.3.1 Endoparasites

Most parasites of humans live inside the host (endo- means internal). These are helminths (worms of various types), protozoans, or sometimes larval stages of arthropods (insects, mites, etc.) Both helminthic and protozoan parasites can infect different tissues and organs of the human body. A great number of endoparasites live in the intestines, or at least pass through the intestines, having been swallowed in food or water. Virtually any organ can be affected, however some parasites like *Trichinella* spp. and *Toxoplasma gondii* live in muscles, larvae of *Echinococcus* spp. and liver flukes occupy the liver, *Schistosomahematobium* targets the urinary bladder and most of the protozoan parasites circulate in blood.

3.3.2 Ectoparasites

Human ectoparasites live on the host (ecto-means outside of). They include fleas, lice, mosquitoes, bugs, mites, ticks etc. In general, ectoparasites attach to the skin to feed and do not remain on the host for their entire lives. Some of these organisms lie in a grey area between endoparasites and ectoparasites. Scabies mites, for example, are generally considered ectoparasites though the female does burrow into the skin. Fly larvae may feed on dead tissue in a wound, but some species never invade healthy tissue.

3.3.3 Life Cycles of Parasites

The life cycles of parasites may be simple or complex. Parasites that are characterised by a simple or direct life cycle have only one host and are described as monoxenous (e.g. life cycle of *Ascarislumbricoides*). The parasite generally spends most of its life in or on the host, and may reproduce within the host. Because offspring must be transmitted to other hosts, however, the parasite or its progeny must have some way of leaving the host, surviving in the external environment for some period, and locating and infecting a new host. Parasites with simple life cycles have both parasitic and free living life stages. The proportion of the total life cycle spent in each stage varies according to the parasite. Parasites with more complex life cycles involving multiple hosts are described as having indirect or heteroxenous life cycles (e.g. life cycle of *Fasciola* spp.). The primary or definitive host of a heteroxenous species is the one in which adult parasites live and reproduce sexually. The secondary or intermediate host (IH) is the host where immature life stages of the parasite live and reproduce asexually. In many cases, the parasite passes through critical developmental stages in the IH. The latter may also aid in transmitting parasites to their final host. Rat flea, for example, is the IH for mammalian parasites such as the tapeworm *Hymenolepisdiminuta*. Some parasites are transmitted directly from one host to another, often by insects, described as vectors. One particularly effective vector for vertebrate parasites is the mosquito, which plays a role in transmission of numerous parasites including heartworm, the viruses that cause yellow fever and encephalitis, and *Plasmodium*, the protozoan that causes malaria.

4.0 CONCLUSION

Parasitology is one of the most prominent areas in life sciences. The nature of medical and economic losses that are caused by parasites makes it relevant in most life sciences discipline. Parasites cause several diseases of human and veterinary importance that requires detail study on their mode of transmission as well as mode of damage. Adequate knowledge of parasites aids in reduction in disease burden and to some extent death.

5.0 SUMMARY

In this unit, the concept of parasitology was examined. Parasitology, traditionally, has included the study of three major groups of animals: parasitic protozoa, parasitic helminths (worms), and those arthropods that directly cause diseases or act as vectors of various pathogens. Procedures in parasitology, types of parasites and hosts, host-parasite relationship, association between hosts and parasites, and general characteristics of human parasites were also considered.

6.0 TUTOR-MARKED ASSIGNMENT

1. With appropriate examples, outline the life cycles of parasites.
2. Explain host-parasite relationship.

7.0 REFERENCES/FURTHER READING

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UNIT 3 PRINCIPLES OF ALLERGY

CONTENTS

1.0 INTRODUCTION

Our focus from this unit is to begin looking at the impact of allergy followed by examining the definition, causes, element involve and response to allergy as it relates to our daily living, noting in particular the various ways our body react to allergy. Allergy is a misguided reaction to foreign substances by the immune system, the body system of defense against foreign invaders, particularly pathogens.

2.0 OBJECTIVES

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

- explain the meaning of allergy
- discuss common causes of allergy
- understand how our body responds to allergic condition
- list the elements that are responsible to allergic reactions.

3.0 MAIN CONTENT

3.1 Concept of Allergy

As was stated earlier on in the introduction, allergy is a misguided reaction to foreign substances by the immune system, the body system of defense against foreign invaders, particularly pathogens (the agents of infection). The allergic reaction is misguided in that these foreign substances are usually harmless. The substances that trigger allergy are called allergen. Examples include pollens, dust mite, molds, dander, and certain foods. People prone to allergies are said to be allergic or atopic.

Although allergies can develop at any age, the risk of developing allergies is genetic. It is related to people with family history of allergy. If neither parent is allergic, the chance for allergies is about 15%. If one parent is allergic, the risk increases to 30% and if both are allergic, the risk is greater than 60%.

Allergens cause the production of immunoglobulin E (IgE), an antibody that all of us have in small amounts. Allergic persons, however, produce IgE in abnormally quantities. Normally, this antibody is important in protecting humans from parasites but not from other allergens. During the sensitization period in allergy, IgE is overproduced. It coats certain potentially explosive cells that contain chemicals including histamine. These chemicals, in turn, cause inflammation and the typical allergic symptoms. This is how the immune system becomes misguided and primed to cause an allergic reaction when stimulated by an allergen. The most common allergic conditions include hay fever (allergic rhinitis), asthma, allergic eyes (allergic conjunctivitis), allergic eczema, hives (urticaria), and allergic shock (also called anaphylaxis and anaphylactic shock). For a summary of each of these conditions as outlined below:
Hay fever (allergic rhinitis) is the most common of the allergic diseases and refers to seasonal nasal symptoms that are due to pollens. Year round or perennial allergic rhinitis is usually due to indoor allergens, such as dust mites or molds. Symptoms result from the inflammation of the tissues that line the inside of the nose (mucus lining or membranes) after allergens are inhaled. Adjacent areas, such as the ears, sinuses, and throat can also be involved. The most common symptoms include: runny nose, stuffy nose, sneezing, nasal itching (rubbing), itchy ears and throat, and post nasal drip (throat clearing).

Asthma is a breathing problem that results from the inflammation and spasm of the lung's air passages (bronchial tubes). The inflammation causes a narrowing of the air passages, which limits the flow of air into and out of the lungs. Asthma is most often, but not always, related to allergies. Common symptoms include: shortness of breath, wheezing, coughing, and chest tightness. Allergic eyes (allergic conjunctivitis) is inflammation of the tissue layers (membranes) that cover the surface of the eyeball and the undersurface of the eyelid. The inflammation occurs as a result of an allergic reaction and features include: Redness under the lids and of the eye overall, watery, itchy eyes, and swelling of the membranes.

Allergic eczema is an allergic rash that is usually not caused by skin contact with an allergen and features the following symptoms include: Itching, redness, and or dryness of the skin, rash on the face, especially children, and rash around the eyes, in the elbow creases, and behind the knees, especially in adults.

Hives (urticaria) are skin reactions that appear as itchy swellings and can occur on any part of the body. Hives can be caused by an allergic reaction, such as to a food or medication, but they also may occur in non-allergic people. Typical hive symptoms are: raised red welts, and intense itching. Allergic shock (anaphylaxis or anaphylactic shock) is a life-threatening reaction that can affect a number of organs at the same time. It typically occurs when the allergen is eaten (for example, foods) or injected (for example, a bee sting). Allergic shock is caused by dilated and "leaky" blood vessels, which result in a drop in blood pressure. Some or all of the following symptoms may occur: Hives or reddish discoloration of the skin; nasal congestion; swelling of the throat, stomach pain, nausea, vomiting; shortness of breath, wheezing; and low blood pressure or shock.

3.2 Body Response to Allergy

Depending on the allergen and where it enters the body that may lead to different symptoms. For example, pollen, when breathed in through the nose, usually causes symptoms in the nose, eyes, sinuses and throat (allergic rhinitis). Allergy to foods usually causes stomach or bowel problems, and may cause hives (urticaria). Allergic reactions can also involve several parts of the body at the same time.

3.2.1 The Nose, Eyes, Sinuses and Throat

When allergens are breathed in, the release of histamine causes the lining of the nose to produce lots of mucus and to become swollen and inflamed. It causes the nose to run and itch sometimes is accompanied by violent sneezing. The eyes may also start to produce tears and a sore throat.

3.2.2 The Lungs and Chest

Asthma can sometimes be triggered during an allergic reaction. When an allergen is breathed in, the lining of the passages in the lungs swells and makes breathing difficult. Not all asthma is caused by allergy, but in many cases, allergy plays a part.

3.2.3 The Stomach and Bowel

Most stomach upsets are caused by richness or spiciness in the food itself, rather than an actual allergy. However, foods which are most commonly associated with allergy include peanuts, seafood, dairy products and eggs. Cow's milk allergy in infants may occur and can cause eczema, asthma, colic and stomach upset. It may also lead to failure to thrive. Some people cannot digest lactose (milk sugar). This intolerance to lactose also causes stomach upsets, but must not be confused with allergy.

3.2.4 The Skin

Skin problems such as eczema (dry, red, itchy skin) and urticaria (also known as hives) often occur. Hives are white itchy bumps which look and feel like insect bites. Food may be a factor in some cases of hives and eczema.

4.0 CONCLUSION

In this unit, we have learnt that gene responsible for allergy can be acquired from parent to offspring. Some examples of allergic agents include pollens, dust mite, molds, dander, and certain foods. People prone to allergies are said to be allergic or atopic. The mechanism of allergy is said to be caused by the production of immunoglobulin E (IgE), an antibody that all of us have in small amounts. Allergic persons, however, produce IgE in abnormally quantities.

5.0 SUMMARY

Allergy can be defined as a misguided reaction to foreign substances by the immune system, the body system of defense against foreign invaders, particularly pathogens. The parts of the body that is affected by allergy include: nose, eyes, sinuses and throat due release of histamine; lungs and chest is caused by allergen when breathed-in; stomach and bowel result from richness or spiciness in the food consumed; Skin problems such as eczema (dry, red, itchy skin) and urticaria (also known as hives) often occur.

6.0 TUTOR-MARKED ASSIGNMENT

1. Define allergen.
2. People prone to allergies are said to be allergic or atopic. Discuss.
3. State and explain parts of the human body that respond to allergy.
4. What do you understand by the word ‘hive’ in allergic response?

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MODULE 3 PEST MANAGEMENT STRATEGIES AND PESTICIDE FORMULATION

UNIT 1 CONCEPT OF PESTS

CONTENTS

1.0 INTRODUCTION

In this unit, we shall examine the concept of pest as it affects us and our environment. Definition and types of pests will also be studied. Pests have both beneficial and detrimental effects that will be addressed here.

2.0 OBJECTIVES

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

- explain the meaning of pests
- discuss the various types of pest
- highlight the importance of pests in our environment
- highlight control strategies against pest of medical importance.

3.0 MAIN CONTENT

3.1 Definition of Pests

A pest is a plant or animal detrimental to humans or human concerns including crops, livestock, and forestry. The term is also used for organisms that cause a nuisance to humans and animals. It is also expressed as a deadly epidemic disease, specifically plague. In its broadest sense, a pest is a competitor of humanity. Animals are called pests when they cause damage to agriculture by feeding on crops or parasitising livestock, such as codling moth on apples, or boll weevil on cotton. An animal could also be a pest when it causes damage to a wild ecosystem or carries germs within human habitats. Examples of these include organisms which vector human diseases, such as rats and fleas, which carry the plague disease, mosquitoes which vector malaria, and ticks which carry Lyme disease.

A species can be a pest in one setting but beneficial or domesticated in another. An example is the European rabbit, which when it was introduced to Australia caused ecological damage beyond the scale inflicted in their natural habitat in Tasmania. Many weeds are also seen as useful under certain conditions, for instance Patterson's curse is often valued as food for honeybees and as a wildflower, even though it can poison livestock. The term "plant pest" has a specific definition in terms of the International Plant Protection Convention and phytosanitary measures worldwide. A pest is any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products. Plants may be considered pests themselves if it is an invasive species.

The animal groups of greatest importance as pests (in order of economic importance) are insects, mites, nematodes and gastropods. Plant pests can be classed as monophagous, oligophagous and polyphagous according to how many hosts they have. Alternatively, they can be divided by feeding type, whether biting and chewing; piercing and sucking; or lapping and chewing. Another approach is to class them by population presence as key pests, occasional pests, and potential pests. The context of pests in this unit will be restricted to pest that affects humans and other animals. Pests and their negative effects on people, pests are injurious to health. Pests can act as carriers for allergens, which irritate people with sensitive medical conditions. Pest’s fecal dropping and shed skin can also become airborne, contaminating the air we breathe in. This does not even include the bacteria that can be found on pests themselves. Common household pests such as cockroaches, rats and mosquitoes are carriers for infectious diseases and must be exterminated lest they overrun a household. In particular, cockroaches can slip through any crack in walls, bringing with them bacteria such as *Salmonella* and *E. coli*. Mosquitoes, on the other hand, carry dengue fever virus/malaria parasites. Since they breed in stagnant water, it is highly recommended that water in containers be used up or covered.

3.2 Types of Pests

A brief description of some of the identified pests or category of pests and an explanation for designating each as a public health pest is giving below:

- ✓ Cockroaches are controlled in order to halt the spread of asthma, allergy, and food contamination.
- ✓ Body, head, and crab lice: These lice are surveyed for and controlled to prevent the spread of skin irritation and rashes, and to prevent the occurrence of louse-borne diseases such as epidemic typhus, trench fever, and epidemic relapsing fever.
- ✓ Mosquitoes: Mosquitoes are controlled to prevent the spread of mosquitoes borne diseases such as malaria; Zika; St. Louis, Eastern, Western, West Nile and LaCrosse encephalitis; yellow fever and dengue fever.
- ✓ Housefly: The housefly is a very common and cosmopolitan insect, which transmits diseases to human. The causative organisms of both amoebic and bacillary dysenteries are picked up by flies from the faeces of infected people and transferred to clean food either on the fly's body hairs/mouthparts/limbs or through their vomit during feeding. Typhoid germs may be deposited on food with the fly's faeces. The house fly causes the spread of yaws germs by carrying them from a yaws ulcer to an ordinary sore. Houseflies also transmit poliomyelitis by carrying the virus from infected faeces to food or drink. Cholera and hepatitis organisms are sometimes fly-borne. Other diseases carried by houseflies are salmonellosis, ,tuberculosis, anthrax, and some forms of ophthalmia. They carry over 100 pathogens and transmit some parasitic worms. The flies in poorer and lower-hygiene areas usually carry more pathogens. It is disturbing to note that some housefly populations have develop/become resistant to most common insecticides.
- ✓ Ticks: The various tick species transmit diseases such as Lyme disease, tick-borne relapsing fever, ehrlichiosis, and Rocky Mountain spotted fever.
- ✓ Bed bugs: They are controlled because their bites can cause allergic reactions.
- ✓ Various rats and mice: Some rats and mice are controlled to prevent the spread of rodent-borne diseases such as Lassa fever and contamination of food for human consumption.
- ✓ Various microorganisms, including bacteria, viruses, and protozoans: These are the subject of control programmes by public health agencies and hospitals for the purpose of preventing the spread of numerous diseases.
- ✓ Various mammals: Many mammals have the potential for direct human injury and can act as disease reservoirs (i.e. rabies, etc.).

3.2.1 Major Insect-Borne Diseases

- Dengue fever - Vectors: *Aedesaegypti* (main vector) *Aedesalbopictus* (minor vector): 50 million people are infected by dengue annually and 25,000 die. Threatens 2.5 billion people in more than 100 countries.

- Malaria - Vectors: *Anopheles* mosquitoes - 500 million become severely ill with malaria every year and more than 1 million die.
- Leishmaniases - Vectors: species in the genus *Lutzomyia* in the New World and *Phlebotomus* in the Old World. Two million people infected.
- Bubonic plague - Principal vector: *Xenopsyllacheopis* At least 100 flea species can transmit plague. Re-emerging major threat several thousand human cases per year. High pathogenicity and rapid spread.
- Sleeping sickness - Vector: Tsetse fly (not all species). Sleeping sickness threatens millions of people in 36 countries of sub-Saharan Africa (WHO).
- Typhus - Vectors: mites, fleas and body lice 16 million cases a year, resulting in 600,000 deaths annually.
- *Wuchereriabancrofti* - most common vectors: the mosquito species: *Culex, Anopheles, Mansonia*, and *Aedes*; affects over 120 million people worldwide.
- Yellow fever - Principal vectors: *Aedessimpsoni, A. africanus,* and *A. aegypti* in Africa, species in the genus *Haemagogus* in South America, and species in the genus *Sabethes* in France -200,000 estimated cases of yellow fever (with 30,000 deaths) per year.

3. 3 Importance of Pests

Infectious agents that cause illness or disease in other living organisms are known as pathogens. These agents may include a wide variety of microorganisms (e.g. mycoplasmas, bacteria, protozoa, spirochetes, and rickettsia) as well as fungi, helminths (roundworms and flatworms), and viruses. A host is any living organism that is infected by a pathogen, regardless of whether or not symptoms of the disease are present. Some hosts die quickly, others may kill or inactivate the pathogen, and still others may retain the pathogen in a condition of readiness to infect other hosts. Whenever a host serves as a source of new infections for other hosts (of the same or different species) it is known as a reservoir. Since pathogens do not have legs or wings, some must be "carried" from one host to another by vectors. Insects and related arthropods are among the most important vectors of such pathogens.

Although epidemics of arthropod-borne diseases have been well-documented throughout human history, it was not until the late 1800's that insects and related arthropods were convincingly linked to the spread of human diseases. In 1878, Patrick Manson first demonstrated that mosquitoes can transmit filariasis, a disease of the blood and lymph caused by roundworms (nematodes). His research was followed in rapid succession by evidence that *Anopheles* spp. mosquitoes carry malaria (Ronald Ross, 1897), fleas spread bubonic plague (P. L. Simond, 1898), and mosquitoes, particularly *Aedesaegypti*, transmit yellow fever (the U.S. Army Yellow Fever Commission headed by Walter Reed,1900). Today, we know of over 200 human diseases that can be spread by insects and related arthropods.

Despite the efforts of modern medicine, the spread of arthropod-borne diseases is still one of the most serious concerns facing public health officials and the medical community in general. The World Health Organization (WHO) estimates that as many as 4 million people die each year from the consequences of arthropod-borne diseases.

Obviously, the problem is most severe in underdeveloped countries where access to good medical care is limited. But even in the United States, encephalitis (mosquito-borne), Lyme disease (tick-borne), and Rocky Mountain Spotted Fever (tick-borne) are still regarded as epidemic-scale problems. The Communicable Disease Control Center (CDC) in Atlanta, Georgia, USA estimates that eight out of every ten Americans will be infected by an arthropod-borne disease sometime during their lives.

Pathogens coexist in elaborate ecological relationships with their hosts and vectors. Without a vector, the pathogen cannot infect new hosts, and without new hosts, the pathogen would eventually become extinct. The term biocenosis (pl. biocenoses) can be used to denote an ecological group that includes a pathogen and all of its hosts and vectors. In some cases, pathogens may simply adhere to a vector's feet or mouthparts, catching a quick ride to a new host. This is known as mechanical transmission. Most of the pathogens that are transmitted mechanically are able to survive short-term exposure to the atmosphere and sunlight. Many types of arboviruses (short for arthropod-borne viruses) are spread by mechanical transmission on the mouthparts of mosquitoes.

In contrast, biological/cyclical transmission occurs when the pathogen survives and develops for a time inside the vector's body, and is later spread to another host. Some of these pathogens relocate within the body of the vector, traveling from the gut to the salivary glands, for example. Others, such as the rickettsia of Rocky Mountain spotted fever, remain dormant in the vector's body and only become activated after feeding commences. Removing a tick within 1-2 hours of attachment usually will ensure too little time for activation and transmission of its pathogens.

Newly hatched insects are usually pathogen-free. After feeding on an infected host, the vector may be able to infect new hosts immediately (in the case of mechanical transmission) or there may be a waiting period (latency) of days to weeks (in the case of biological transmission) while the pathogen migrates or reproduces inside the vector's body. Once infected, a vector may retain the pathogen for the rest of its life (persistent infection) or may eventually eliminate or inactivate the pathogen (non-persistent infection). Arthropod-borne diseases have shaped the course of human history. Ever since medieval times, epidemics of bubonic plague have swept through the civilized world. It is estimated that nearly one-fourth of the population of Europe (20-25 million people) died of plague (The Black Death) during the 14th century. Edgar Allan Poe described the gruesome death of plague victims in his story “The Masque of the Red Death”.

Forty years later, in 1856, the Russian army, weakened by tularemia after marching through fly-infested swamps in Turkey, was soundly defeated by the allied forces of Europe to end the Crimean War. During the American Civil War (1861-1865), 1.2 million cases of malaria were treated and 8,000 soldiers died. More than 100,000 troops were sidelined with malaria during World War II, yet the Allied army was in much better health than the Japanese largely due to widespread use of a "new" insecticide (DDT) to control lice and mosquitoes. Many historians believe that, even without the atomic bomb, Japan's army would not have survived much longer against the onslaught of typhus and malaria.

Demographics and civilization have also been shaped by arthropod-borne disease. Deteriorating socio-economic conditions during the Russian Revolution (1917) prompted Lenin to declare, "Either socialism will defeat the louse, or the louse will defeat socialism." Even today, much of equatorial Africa is uninhabitable because of endemic sleeping sickness vectored by the tsetse fly. The World Health Organization estimates that more than 500 million people throughout the world currently suffer from the debilitating effects of arthropod-borne diseases.

4.0 CONCLUSION

In this unit, pest was defined as animal or plant that causes damage to man or man's property. Some terminologies related to pest were highlighted. Most pests are either vectors or carrier/agents of pathogens. These agents may include a wide variety of microorganisms (e.g. mycoplasmas, bacteria, protozoa, spirochetes, and rickettsia) as well as fungi, helminths (roundworms and flatworms), and viruses.

5.0 SUMMARY

A species can be a pest in one setting but beneficial or domesticated in another. Animals are called pests when they cause damage to agriculture by feeding on crops or parasitise livestock, such as codling moth on apples, or boll weevil on cotton. Some major insect-borne diseases examined in this unit include: Dengue fever, malaria, leishmaniasis, bubonic plague, sleeping sickness, typhus, *Wuchereriabancrofti* and yellow fever. Despite the efforts of modern medicine, spread of arthropod-borne diseases is still one of the most serious concerns facing public health officials and the medical community in general. The WHO estimates that as many as 4 million people die each year from the consequences of arthropod-borne disease and the figure maybe higher in the under-developed and developing countries.

6.0 TUTOR-MARKED ASSIGNMENT

1. Define Pest.
2. Expatiate on the role of arthropods in pathogens transmission.
3. Outline the importance of pests in the field of medicine.

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UNIT 2 METHODS OF PEST MANAGEMENT

CONTENTS

1.0 INTRODUCTION

This unit deals with the management, control strategies of pests. Pest management is a means of reducing the pest numbers to an acceptable threshold. There are various control methods that are used in control measures. Methods of control can be categorized into chemical, biological, cultural, physical/mechanical, or genetic. The choice of control methods is determined by the intensity of the damage and type of pest.

2.0 OBJECTIVES

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

- understand the concept of pest management
- discuss the various tools used in pest management
- explain the types of control strategies used in pest management
- know the pro and cons of control strategies used in pest management.

3.0 MAIN CONTENT

3.1 What is Pest Management?

Pest management is a means to reduce pest numbers to an acceptable threshold. An acceptable threshold, in most cases, refers to an economically justifiable threshold where application of pest control measures reduces pest numbers to a level below which additional applications would not be profitable (i.e. where additional costs of control exceed additional benefits). Pest eradication (i.e., complete removal) is usually not a viable option.

Integrated Pest Management (IPM) programs are successful for a simple reason. They recognize that pest management is a process, not a one-time event and that relying solely on chemical controls when so many other tools are available is never the best solution. By addressing the underlying causes of pest infestations – access to food, water and shelter, IPM can prevent infestation before pesticides are even considered. In practice, IPM is an ongoing cycle of seven critical steps:

3.1.1 Inspection

The cornerstone of an effective IPM program is a schedule for regular inspections. For food processors, weekly inspections are common, and some plants inspect even more frequently. These routine inspections should focus on areas where pests are most likely to appear – i.e. the receiving docks, storage areas, employee break rooms, sites of recent ingredient spills, etc. – and identify any potential entry points such as food and water sources, or harborage zones that might encourage pest problems.

3.1.2 Preventive Action

As regular inspections reveal vulnerabilities in pest management programme, take steps to address them before they cause a real problem. One of the most effective prevention measures is exclusion, i.e. performing structural maintenance to close potential entry points during inspection. By physically keeping pests out, it can reduce the need for chemical counter-measures. Likewise, sanitation and housekeeping will eliminate potential food and water sources, thereby reducing pest pressure.

3.1.3 Identification

Different pests have different behaviors. By identifying the problematic species, pests can be eliminated more efficiently and with the least risk of harm to other organisms. Professional pest management always starts with the correct identification of the pest in question. There is need for pest control provider to undergo rigorous training in pest identification and behavior.

3.1.4 Analysis

Once pest is properly identified, there is need to figure out why the pest is in your facility. Is there food debris or moisture accumulation that may be attracting it? What about odors? How are the pests finding their way in – perhaps through the floors or walls? Could incoming shipments be infested? The answers to these questions will lead to the best choice of control techniques.

3.1.5 Treatment Selection

Integrated pest management stresses the use of non-chemical control methods such as exclusion or trapping, before chemical options. When other control methods failed or are inappropriate for the situation, chemicals may be used in least volatile formulations in targeted areas to treat the specific pest. Often, the "right treatment" will consist of a combination of responses from chemical treatments to baiting to trapping. But by focusing on non-chemical options first, it can ensure that pest management programme is effectively eliminating pests at the least risk to the food safety programme, non-target organisms and the environment.

3.1.6 Monitoring

Since pest management is an ongoing process, constantly monitoring facility for pest activity and facility and operational changes can protect against infestation and help eliminate existing ones. Since the pest management professional most likely visits your facility on a bi-weekly or weekly basis, the staff needs to be the daily eyes and ears of the IPM program. Employees should be cognizant of sanitation issues that affect the programme and should report any signs of pest activity.

3.1.7 Documentation

Up-to-date pest control documentation is one of the first signs to an auditor that the facility takes pest control seriously. Important documents include a scope of service, pest activity reports, service reports, corrective action reports, and trap layout maps, lists of approved pesticides, pesticide usage reports and applicator licenses.

3.2 Control Methods

Methods of control can be categorized into chemical, biological, cultural, physical/mechanical, or genetic; these are discussed in further detail below.

- ✓ **Chemical:** Chemicals such as insecticides, herbicides, rodenticides are broad-spectrum (non-selective) or narrow-spectrum (selective), and can be organic or inorganic. Chemicals used to regulate pest abundance can act as nerve toxins (for insects and mammals) and growth regulators/inhibitors. Chemicals can also be used to affect pest abundance through more indirect means, such as releasing pheromones to disrupt breeding behavior and interfere with mating. Chemical pesticides are often toxic to non-target organisms including the pest's natural enemies and can persist in the environment affecting water supply, soil productivity, and air quality, and can be biomagnified in the food chain. Inappropriate use of pesticides can result in target pest resurgence from killing off natural enemies, secondary pest outbreaks by removing natural enemies of other organisms and allowing them to rise to pest status, and evolved resistance to the pesticide.
- ✓ **Biological:** Biological control involves the use of a pest's natural enemies to control pest abundance. Examples of natural enemies include predators, pathogens, parasites and parasitoids. Measures to conserve or enhance the impact of natural enemies should be attempted first. Perhaps biological control is most known for importation of natural enemies, often from the pest's area of origin, to control non-native pests. Vedaliabettle was imported to control cottony cushion scales, which were attacking California citrus orchards. A number of safeguards are necessary before implementing importation actions to ensure imported organisms will not pose additional threats to non-target organisms. A third approach to biological control involves augmenting natural enemies through rearing and periodic releases and can be inoculative (natural enemies are released early in the season) or inundative (natural enemies are released as a biological pesticide).
- ✓ **Cultural:** The effectiveness of natural enemies can be compromised by human practices. Application of broad-spectrum pesticides which kill off natural enemies in addition to target pest species, the type of crop plant, the crop environment, and cropping practices. Modern crop varieties often inadvertently create conditions which favor pest species (e.g., pest species which have bored deeper into larger fruit making them inaccessible to natural enemies). Crops are often monocultures, consisting of a single crop species, which creates a homogenous habitat often lacking key requirements of natural enemies, thus favoring pest species. Moreover, many harvesting practices prevent natural enemies from persisting in annual crops. Examples of cultural practices that encourage natural enemies and discourage pest persistence include intercropping to make it more difficult for pests to find a host plant, planting trap crops which attract pests away from harvest crops and which can later be treated with select application of pesticides, and delaying planting times to coincide with times where pests have emerged and died off for the season.

- ✓ **Physical:** Manual or mechanical removal, or installation of physical barriers can be used to exclude pest species. Removal methods include use of animal traps, sticky cards for insects, manual removal of insects from plants (e.g., hand picking or spraying with a hose), removing diseased or infected materials (e.g., pruning branches or removing diseased litter). Physical barriers such as fences, nets, mulch, and tree trunk guards can exclude pests and reduce the damage they inflict.
- ✓ **Genetic:** Genetic alteration to reduce pest impacts is not as widely known or publicly available as other control options. Autocide is one type of genetic control and involves using the pest itself to induce increased mortality rates. Sterile males of an insect type are introduced into a population of the same insect type/species, which, after mating with females, creates infertile eggs. This is an expensive option with many limitations including potential for reduced competitive viability of the introduced sterile males against naturally occurring fertile males. Straightforward genetic manipulation to create pest resistant plant strains is another form of controlling pest impacts. However, genetic manipulation research and development is costly and introduces a whole other series of ethical and environmental issues that are not easily addressed. Genetic manipulation is not a viable control option for the general public.
- ✓ **Integrated Pest Management (IPM)**: Is an increasingly popular process for controlling pests. The IPM considers the ecosystem as a whole and takes into consideration a balanced mix of the aforementioned control methods to produce the most effective and least damaging plan. All the methods are mutually augmentative with chemical control means as the last resort in the plan. Ideally, an IPM plan would result in a sustainable system without need for much costly follow-up maintenance.

3.3 Hygiene as a Tool of Pest Control

When houses and yards are kept clean, there is no food for pests and nowhere for them to live and breed, and this in turn means that there are few pests. Pests can be controlled by practicing good hygiene in the following ways:

- Clean up after meals: Put food scraps in the bin, and wash and dry plates, cups, glasses, cutlery and cooking pots after use.
- Put all rubbish into the bin
- Wrap all food scraps tightly in paper before putting them in the bin
- Keep all the benches, cupboards and floors clean and free of food scraps
- Regularly clean behind stoves, refrigerators and other household appliances
- Keep food in containers with tight-fitting lids
- Use the toilet properly. Make sure that all urine and faeces go into the pedestal pan and that the toilet is flushed after use. Toilet paper is the only kind of paper that should be flushed down the toilet.
- Make sure the toilet is clean and the cistern works correctly
- Make sure that all septic tanks and leach drains are well sealed
- Make sure that the community rubbish tip is operated correctly with the rubbish being buried regularly
- Use fly screens to stop pests entering the house and seal holes around pipes

There is little point to having a pesticide program to control domestic pests if the relevant hygiene factors are not addressed as well. The pests will soon return if good hygiene is not maintained.

4.0 CONCLUSION

Integrated Pest Management is an ongoing cycle of seven critical steps: inspection, preventive action, identification, analysis, treatment, monitoring and documentation. However, control methods involved in pest management are chemical, biological, cultural, physical, genetic and integrated pest management. Proper hygiene aids in controlling pest.

5.0 SUMMARY

Definition of pest management and various control strategies were evaluated in this unit. Pests of medical, veterinary and agricultural importance are always around us in one way or the other. Pest is everyone’s business as we live with them, controlling them is key when they exceed threshold.

6.0 TUTOR-MARKED ASSIGNMENT

1. Integrated pest management is the best method of controlling pest outbreak. Discuss.
2. Highlight major tools used in controlling of medical and agricultural pest.

7.0 REFERENCES/FURTHER READING

*Woody Ornamental Insect, Mite, and Disease Management Guide (*1995).Penn State Extension. Penn State Publications Distribution Center, 112 Agricultural Administration Building, University Park, PA, 16802-2600.

UNIT 3 WHAT IS PESTICIDES

CONTENTS

1.0 INTRODUCTION

This unit will be addressing pesticides that are commonly used in the environment. The obnoxious nature of pests has made human to look for remedy on the damage pest cause. Pesticides can be said is any form or substance(s) that kill or reduce the population of pest. The pesticides can be in form of solid, liquid, dust or smoke that brings about the desired effect.

2.0 OBJECTIVES

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

- define pesticide
- understand what pesticides are?
- know the uses of pesticides
- know the safety precautions in using pesticides.

3.0 MAIN CONTENT

3.1 Definition of Pesticides

Pesticide is any substance or mixture of substances intended for preventing, destroying, or controlling any pest, including vectors of human or animal diseases, unwanted species of plants or animals, causing harm during or otherwise interfering with the production, processing, storage, transport, or marketing of food, agricultural commodities, wood and wood products or animal feedstuffs, or substances that may be administered to animals for the control of insects, arachnids, or other pests in or on their bodies. Pesticides are used in public health to kill vectors of diseases, such as mosquitoes, and in agriculture, to kill pests that damage crops. By their nature, pesticides are potentially toxic to other organisms, including humans, and need to be used safely and disposed of properly. The use of pesticides is so common that the term pesticide is often treated as synonymous with plant protection product. It is commonly used to eliminate or control a variety of agricultural pests that can damage crops and livestock and reduce farm productivity. The most commonly applied pesticides are insecticides that kill insects, herbicides to kill weeds, rodenticides to kill rodents, and fungicides to control fungi, mold, and mildew.

3.1.1 Brief History of Pesticides

Pesticides are not recent inventions! Many ancient civilisations used pesticides to protect their crops from insects and other pests. Ancient Sumerians used elemental sulfur to protect their crops from insects. Whereas, Medieval farmers experimented with chemicals using arsenic, lead on common crops. The Chinese used arsenic and mercury compounds to control body lice and other pests. Greeks and Romans used oil, ash, sulfur, and other materials to protect themselves, their livestock, and their crops from various pests. Meanwhile, in the nineteenth century, researchers focused more on natural techniques involving compounds made with the roots of tropical vegetables and chrysanthemums. In 1939, Dichloro-Diphenyl-Trichloroethane (DDT) was discovered, which has become extremely effective and rapidly used as the insecticide in the world. However, twenty years later, due to biological effects and human safety, DDT was banned in almost 86 countries.

3.2 Uses of Pesticides

Pesticides are used to control organisms that are considered to be harmful. For example, they are used to kill mosquitoes that can transmit potentially deadly diseases like West Nile virus, yellow fever, and malaria. They can also kill bees, wasps or ants that can cause allergic reactions. Insecticides can protect animals from illnesses that can be caused by parasites such as fleas. Pesticides can prevent sickness in humans that could be caused by moldy food or diseased produce. Herbicides can be used to clear roadside weeds, trees, and brush. They can also kill invasive weeds that may cause environmental damage. Herbicides are commonly applied in ponds and lakes to control algae and plants such as water grasses that can interfere with activities like swimming and fishing and cause the water to look or smell unpleasant. Uncontrolled pests such as termites and mold can damage structures such as houses. Pesticides are used in grocery stores and food storage facilities to manage rodents and insects that infest food such as grain. Each use of a pesticide carries some associated risk. Proper pesticide use decreases these associated risks to a level deemed acceptable by pesticide regulatory agencies such as the United States Environmental Protection Agency (EPA) and the Pest Management Regulatory Agency (PMRA) of Canada.

Proper pesticide use starts before application. Take time to observe the surrounding area. Look for children, nearby farm workers and sensitive crops. Then, read the label. Some label instructions specify the maximum wind speed for application. Others simply indicate that the product should not be used when weather conditions favour drift. Strong winds blowing pesticides onto surrounding properties result in the largest number of complaints, so care should be taken to apply when winds are light and directed away from sensitive vegetation. Other precautions include leaving a buffer strip, increasing droplet size, lowering spray pressure and using a drift control additive. Finally, keep accurate, detailed records, including wind speed and direction during application, to avoid frivolous complaints.

3.3 Importance of Pesticides

Pesticides can save farmers' money by preventing crop losses to insects and other pests. In the U.S., farmers get an estimated fourfold return on money they spend on pesticides. One study found that not using pesticides reduced crop yields by about 10%. Another study, conducted decade ago found that a ban on pesticides in the United States may result in a rise of food prices, loss of jobs, and an increase in world hunger.

Pesticides may cause acute and delayed health effects in people who are exposed. Pesticide exposure can cause a variety of adverse health effects, ranging from simple irritation of the skin and eyes to more severe effects such as affecting the nervous system, mimicking hormones causing reproductive problems, and also causing cancer. A 2007 systematic review found that "most studies on non-Hodgkin lymphoma and leukemia showed positive associations with pesticide exposure" and thus concluded that cosmetic use of pesticides should be decreased. There are associations between organophosphate insecticide exposures and neurobehavioral alterations.

Vector-borne diseases are most effectively tackled by killing the vectors. Insecticides are often the only practical way to control the insects that spread deadly diseases such as malaria, resulting in an estimated 5000 deaths each day. Malaria is one of the leading causes of morbidity and mortality in the developing world. Disease control strategies are crucially important also for livestock.

The major advantage of pesticides is that they can save farmers by protecting crops from insects and other pests. However, some other primary benefits are listed below:

- Controlling pests and plant disease vectors.
- Controlling human/livestock disease vectors and nuisance organisms.
- Controlling organisms that harm other human activities and structures.

3.3.1 Improving Productivity

Tremendous benefits have been derived from the use of pesticides in forestry, public health and the domestic sphere – and, of course, in agriculture, a sector upon which the Indian economy is largely dependent. Pesticides have been an integral part of the process by reducing losses from the weeds, diseases and insect pests that can markedly reduce the amount of harvestable produce. Considerable economic losses” would be suffered without pesticide use and quantified the significant increases in yield and economic margin that result from pesticide use. Moreover, in the environment most pesticides undergo photochemical transformation to produce metabolites which are relatively non-toxic to both human beings and the environment.

4.0 CONCLUSION

This unit has furnished us with the concepts used in controlling pests through the use of pesticides. The use of pesticides in controlling pests has brought some relieves to humans. Some of the benefits of pesticides includes: reduction in plant and animal vectors, reduction in disease burden and decrease in attacks by some pests on physical structures.

5.0 SUMMARY

Pesticides are used in public health to kill vectors of diseases, such as mosquitoes, and in agriculture, to kill pests that damage crops. By their nature, pesticides are potentially toxic to other organisms, including humans, and need to be used safely and disposed of properly. Pesticides have been in existence through use of sulfur from ancient civilization to the 19^{th} century where scientists used compound based materials in controlling pests. Uses of insecticides have tremendous importance to humans ranging from improve productivity of farm produce/products to farmers to disease vector control.

6.0 TUTOR-MARKED ASSIGNMENT

1. What do understand by the word pesticides?
2. Justify the statement that says, ‘pesticides control is not new to human’.

7.0 REFERENCES/FURTHER READING

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UNIT 4 TYPES OF PESTICIDES

CONTENTS

1.0 INTRODUCTION

In this unit, the most insecticide type in practice will be studied. This unit also equips you with classification of insecticides based on their activities on pests and their application. Pesticides have beneficial and negative effects on the environment. Before adopting a type of pesticide, the pest in question has to be evaluated so that it does not affect the untargeted organisms.

2.0 OBJECTIVES

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

- understand the terminologies associated with pesticides
- describe chemical nature of pesticides
- explain formulation of pesticides.

3.0 MAIN CONTENT

3.1 Classification Based on Activities

There are many different types of pesticides, each is meant to be effective against specific pests. The term "-cide" comes from the Latin word "to kill". These are grouped according to the types of pests they kill as in the examples below:

1. Insecticides – insects
2. Herbicides – plants
3. Rodenticides – rodents (rats & mice)
4. Bactericides – bacteria
5. Fungicides – fungi
6. Larvicides – larvae

Biodegradability of pesticides

Pesticides can also be considered as:

- **Biodegradable:** The biodegradable kind is that which can be broken down by microbes and other living beings into harmless compounds.
- **Persistent (Non-biodegradabe):** These are the persistent ones which may take months or years to break down.

3.2 Classification of Pesticides Based on Chemical Nature

Another way to classify pesticides is to consider those that are chemical forms or are derived from a common source or production method.

Chemically-related pesticides

- Organophosphate: Most organophosphates are insecticides that affect the nervous system by disrupting the enzyme that regulates a neurotransmitter.
- Neonicotinoids**:** Neonicotinoid insecticides target the nervous system of insects, blocking an acetylcholine receptor. They are a class of synthetic compounds based on the naturally occuring compound nicotine, itself used as an agricultural insecticide. They have become one of the most commonly used insecticide classes in recent years, with compounds registered on many major crops for foliar application and/or seed treatment. Active ingredients include imidicloprid, clothiandin, thiamethoxam, acetamiprid, thiacloprid, and dinotefuran. They are sold under a variety of trade names, and all are classified as highly toxic or toxic to honey bees. They are systemic insecticides, meaning that the compounds are present in the plant tissues rather than just on the surface.
- There is evidence to suggest that pollinators like bees may be exposed to pesticides via the resources they collect, but further research is required to determine the details and how such problems might be mitigated. Neonicotinoid compounds may also pose a hazard if used as a seed treatment or sprayed before bloom, as they can be present in dust from seed drills, pollen, nectar, and guttation water. Neonicotinoids are the group of pesticides most commonly implicated as a contributing cause of widespread honey bee losses, both through direct toxic action and chronic effects on the immune system. Research is ongoing into the role of these compounds in honey bee decline, but it is recommended that their use near bees or blooming crops or wildflowers be avoided. The Xerces Society recently published a review of the scientific literature on the effects of neonicotinoids on bees**.**
- N-Methyl Carbamates:N-methylcarbamates, or simply carbamates, are commonly used insecticides. The names of many of these active ingredients end in the suffix -carb, and the class also includes several insecticides that are responsible for many bee poisonings (carbaryl, carbofuran). Like the organophosphates, they are inhibitors of acetylcholine metabolism in the nervous system, and thus share similar symptoms. Symptoms of carbamate poisoning in honey bees include an inability to fly in adult bees, dead brood or newly

emerged workers, or queen loss. Sub-lethal effects on the queen have also been recorded, such as poor or erratic egg laying performance.

- Organochlorine insecticides: They were commonly used earlier, but now many countries have removed Organochlorine insecticides from their market due to their health and environmental effects and persistence (e.g., DDT, chlordane, and toxaphene).
- Pyrethroid: Pyrethroid insecticides are a class of synthetic compounds based on the naturally occuring compound pyrethrin, which is extracted from chrysanthemum flowers. Pyrethrin is noted for its quick 'knock-down' of insects, but the natural compound is not always lethal, and degrades readily in the environment. Synthetic pyrethroids have been chemically stabilized to increase their persistence in field applications and/or increase toxicity. Pyrethroids are sometimes mixed with other insecticides, either in a brand-name product or tank-mixed at the application site. Symptoms of pyrethroid poisoning in honey bees include regurgitation of collected nectar.
- Sulfonylurea herbicides: The sulfonylureas herbicides have been commercialized for weed control such as pyrithiobac-sodium, cyclosulfamuron, bispyribac-sodium, terbacil, sulfometuron-methyl Sulfosulfuron, rimsulfuron, pyrazosulfuron-ethyl, imazosulfuron, nicosulfuron, oxasulfuron, nicosulfuron, flazasulfuron, primisulfuron-methyl, halosulfuron-methyl, flupyrsulfuron-methyl-sodium, ethoxysulfuron, chlorimuron-ethyl, bensulfuron-methyl, azimsulfuron, and amidosulfuron.
- Biopesticides: The biopesticides are certain types of pesticides derived from such natural materials as animals, plants, bacteria, and certain minerals.
- Insect Growth Regulators: These compounds are analogues of hormones or other compounds that regulate the development of immature insects. Novaluron (the most common active ingredient in this group) has been found to have very low toxicity to adults of several bee species, including honey bees, in laboratory toxicological studies. However, it has been linked to impaired brood development in honey bees in the field.

3.3 Pesticide Active Ingredients and Formulations

Active ingredients are the chemicals in pesticide products that kill, control, or repel pests. For example, the active ingredients in herbicide are the ingredient(s) that kill weeds. Often, the active ingredients make up a small portion of the whole product. Pesticide product labels include the name of each active ingredient and its concentration in the product.

Pesticide formulations are a combination of one or more active ingredients (a.i.), which control pests, and several inert ingredients. Many active ingredients are not soluble in water. Some may be toxic or unsafe to handle. Others may be unstable during storage. The inert ingredients are included in a formulated product to solve these problems. Some inert ingredients pose health risks to pesticide handlers or applicators so their characteristics, along with those of the active ingredient, determine the signal word that appears on the product label. Examples of pesticides are fungicides, herbicides, and insecticides. Examples of specific synthetic chemical pesticides are glyphosate, Acephate, Deet, Propoxur, Metaldehyde, Boric Acid, Diazinon, Dursban, DDT, Malathion, etc.

4.0 CONCLUSION

In this unit, we were able to look at the types of pesticides that are commonly used in our environment. There are many different types of pesticides, each is meant to be effective against specific pests. Most pesticides derive their names from the pest they kill, while other is on the degradability of the pesticides. The compounds used in formulating the pesticides are also used in classifying it.

5.0 SUMMARY

The activity of pesticide has led to their grouping into: insecticides, herbicides, rodenticides, bactericides, fungicides and larvicides among others. Chemicaly-related pesticides are grouped into organophosphate, Neonicotinoids, N-Methyl Carbamates, Organochlorine, Pyrethroid, Sulfonylurea, Biopesticides and Insect Growth Regulators, which were examined in this unit. Some pesticides are soluble in water others in non-polar compounds. Most pesticides are synthetics. Examples of specific synthetic chemical pesticides are glyphosate, Acephate, Deet, Propoxur, Metaldehyde, Boric Acid, Diazinon, Dursban, DDT, Malathion, etc.

6.0 TUTOR-MARKED ASSIGNMENT

1. Outline chemically-related pesticides.
2. What are pesticides active ingredients?

7.0 REFERENCES/FURTHER READING

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MODULE 4 RADIATION, OIL SPILL, GAS FLARING, AND ENVIRONMENTAL MANAGEMENT TECHNIQUES

UNIT 1 RADIATION AND RISK OF EXPOSURE

CONTENTS

1.0 INTRODUCTION

In this unit, we intend to cover radiation in terms of defining what it is, and sources. Radiation can be either ionizing or non-ionising. Non-ionising radiation is lower energy radiation that comes from the lower part of the electromagnetic spectrum. Radiation provides various benefits for healthcare, but it must be used correctly. It is called non-ionising because it does not have enough energy to completely remove an electron from an atom or molecule. Examples of non-ionising radiation include visible light, infrared light, microwave radiation, radio waves, and longwave, or low frequency, radiation. Ionising radiation has enough energy to carry out ionisation, which means it can detach electrons from atoms or molecules. Ionisingradiation comes from both subatomic particles and the shorter wavelength portion of the electromagnetic spectrum. Examples include ultraviolet (UV) radiation, X-rays, and gamma rays from the electromagnetic spectrum and subatomic particles such as alpha particles, beta particles, and neutrons. Subatomic particles are usually emitted as an atom decays and loses protons, neutrons, electrons, or their antiparticles. People are exposed to natural as well as human-made sources of radiation on a daily basis. Natural radiation comes from many sources including more than 60 naturally-occurring radioactive materials found in soil, water and air. Radon, a naturally-occurring gas, emanates from rock and soil and is the main source of natural radiation. Every day, people inhale and ingest radio nuclides from air, food and water. Radiation can be prevented if properly handled.

2.0 OBJECTIVES

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

- explain and discuss radiation
- understand the sources of radiation
- distinguish between ionising and non-ionising radiation
- know ways in which radiation gets to humans and other living organisms
- understand how it affects living organisms
- adopt protective measures against radiation exposure.

3.0 MAIN CONTENT

3.1 Meaning of Radiation

Radiation can be described as energy or particles from a source that travel through space or other mediums. Light, heat, microwaves and wireless communications are all forms of radiation. Ionising radiation is emitted by a large range of natural materials, can be produced by everyday devices such as X-ray machines, and can also be emitted by unstable atoms. Atoms become unstable when they have the wrong amount of mass required to keep them stable, an excess of energy, or both. Unstable atoms are said to be radioactive. In order to reach stability, these atoms give off, or emit, energy and/or mass. The energy is emitted in the form of electromagnetic radiation (i.e. light) and the mass is in the form of tiny particles. These emissions are called nuclear radiation and such atoms are said to be radioactive. Gamma radiation is an example of electromagnetic radiation. Beta and alpha radiation are examples of emitted particles. Ionising radiation can also be produced by devices such as X-ray machines.

Atoms with unstable nuclei are said to be *radioactive*. In order to reach stability, these atoms give off or emit the excess energy or mass. These emissions are called *radiation*. The kinds of radiation are electromagnetic (like light) and particulate (i.e., mass given off with the energy of motion). Gamma radiation and x-rays are examples of electromagnetic radiation. Gamma radiation originates in the nucleus while x-rays come from the electronic part of the atom. Beta and alpha radiation are examples of particulate radiation.

Non-ionizing radiation is lower energy radiation that comes from the lower part of the electromagnetic spectrum. Radiation provides various benefits for healthcare, but it must be used correctly. It is called non-ionising because it does not have enough energy to completely remove an electron from an atom or molecule. Examples of non-ionising radiation include visible light, infrared light, microwave radiation, radio waves, and long wave, or low frequency, radiation. Ionising radiation is emitted when radioactive substances decay. Radioactive decay occurs when the nucleus of an atom spontaneously decays by emitting a particle (an alpha particle, an electron, or one or more neutrons).

The four forms of ionising radiation are alpha particles, beta particles, gamma rays, and, indirectly, neutrons. All have enough energy to ionise atoms, in other words, remove one or more electrons from an atom. An alpha particle consists of two protons and two neutrons, the equivalent of the nucleus of a helium atom. Alpha particles readily ionize material they contact and transfer energy to that material's electrons. An alpha particle can travel several millimeters in air, but in general its range decreases with increasing density of the medium. For example, alpha particles do not penetrate the outer layer of human skin, but if inhaled, alpha particles can damage lung tissue.

A beta particle is an electron or a positron and is much lighter than an alpha particle. Thus, it takes beta particles a longer distance than alpha particles to lose energy. A medium-energy beta particle travels about one meter in air and one millimeter in body tissues. Gamma rays are electromagnetic radiation. A radioactive element may emit gamma rays (in discrete bundles, or quanta, called photons) if the nucleus remaining after alpha or beta decay is in an excited state. Gamma rays can penetrate much more deeply than alpha or beta particles; a high-energy gamma ray photon may pass through a person without interacting with tissue at all. When gamma rays interact with tissue, they ionise atoms..

Neutrons are neutral particles that have no electric charge. Unlike alpha and beta particles, they do not interact with electrons or cause ionisation directly. Neutrons can, however, ionise indirectly in a variety of ways: elastic collisions, inelastic scattering, non-elastic scattering, capture reactions, or spallation processes. These processes variously result in the emission of gamma rays, beta radiation, and in the case of spallation, more neutrons.

Exposure to ionizing radiation can be classified into three exposure situations. The first, planned exposure situations result from the deliberate introduction and operation of radiation sources with specific purposes, as is the case with the medical use of radiation for diagnosis or treatment of patients, or the use of radiation in industry or research. The second type of situation, existing exposures, is where exposure to radiation already exists, and a decision on control must be taken – for example, exposure to radon in homes or workplaces or exposure to natural background radiation from the environment. The last type, emergency exposure situations, results from unexpected events requiring prompt response such as nuclear accidents or malicious acts. Medical use of radiation accounts for 98% of the population dose contribution from all artificial sources, and represents 20% of the total population exposure. Annually worldwide, more than 3600 million diagnostic radiology examinations are performed, 37 million nuclear medicine procedures are carried out, and 7.5 million radiotherapy treatments are given.

3.2 Measuring Radioactivity

Ionising radiation can be measured using units of electron volts, ergs, and joules. The electron-volt(abbreviated eV) is a unit of energy associated with moving electrons around. An electron is "tightly bound" in a hydrogen atom (one proton and one electron). It takes energy to move this electron away from the proton. It takes 13.6 electron-volts of energy to move this electron completely away from the proton. We say then that the atom is "ionised." One electron-volt is only 1.6 x 10^{-19} joules of energy. One joule (J) is equivalent to the amount of energy used by a one-watt light bulb lit for one second. The energy associated with the radioactive decay ranges from thousands to millions of electron-volts per nucleus, which is why the decay of a single nucleus typically leads to a large number of ionisations.

3.3 Dose Exposure Measurement

Placing your body near a radioactive source will results in exposure to irradiation. To evaluate the hazard from this exposure one must compute the absorbed dose. This is defined as the energy imparted to a defined mass of tissue. Dose is generally not uniform over the body. A radioactive substance can be selectively taken up by different organs or tissue. Radiation doses are often calculated in the units of rad (short for radiation absorbed dose). One rad is 100 ergs/gram, in other words, 100 ergs of energy absorbed by one gram of a given body tissue. An erg is one-ten-millionth of a joule. One hundred rad equals one Joule/kilogram (J/kg), which also equals one Gray (Gy), the standard international unit for measuring radiation dose. Suppose time is involved? Then we are talking about dose rate (or dose per unit time). An example of the units for dose rate is millirad/hour. In everyday terms, a joule (and even more so, an erg) is a rather small amount of energy. But in terms of ionisation potential of molecules or elements, a joule is a huge amount of energy. One joule of ionising radiation can cause tens of thousands of trillions of ionisations.

The potential damage from an absorbed dose depends on the type of radiation and the sensitivity of different tissues and organs. The *effective dose* is used to measure ionising radiation in terms of the potential for causing harm. The sievert (Sv) is the unit of effective dose that takes into account the type of radiation and sensitivity of tissues and organs. It is a way to measure ionising radiation in terms of the potential for causing harm. The Sv is a very large unit so it is more practical to use smaller units such as millisieverts (mSv) or microsieverts (μSv). There are one thousand μSv in one mSv, and one thousand mSv in one Sv. In addition to the amount of radiation (dose), it is often useful to express the rate at which this dose is delivered (dose rate), such as microsieverts per hour (μSv/hour) or millisievert per year (mSv/year).

The roentgen measures the amount of ionisation in the air caused by radioactive decay of nuclei. In non-bony biological tissue, one roentgen is the equivalent of about 0.93 rad. In air, one roentgen equals 0.87 rad. Dials that show calibration in mR/hr are reading milliroentgen per hour. Physically speaking, the most elementary way to measure the effect of radiation is to measure the amount of energy deposited in a given weight of material. However, the deposition of energy is only one aspect of the potential of radiation to cause biological damage. The damage caused per unit of deposited energy is greater when it is deposited over a shorter distance. Hence an alpha particle, which would deposit its entire energy over a very short distance, causes far more damage per unit of energy than a gamma ray, which deposits its energy over a longer track. The weight of biological matter in which the energy is deposited is also important. The sensitivities of different organs also vary. The concept of relative biological effectiveness (RBE) has been created to try to capture the relative efficiency of various kinds of radiation in producing biological damage.

The RBE varies according to the organ exposed, the age of exposure, and other factors. A single factor, called the quality factor, for converting deposited energy in rad is used for regulatory purposes, even though this represents a considerable simplification of real life risks. For beta and gamma radiation, the quality factor used is 1, that is 1 rad = 1 rem. Alpha radiation is far more damaging per unit of energy deposited in living tissue. Currently, the quality factor for alpha is 20 (multiply rad of alpha radiation by 20 to get rem). We say “currently” because the quality factor for alpha radiation has changed over the years. The current quality factor generally used for neutrons is 10.

Epidemiological studies on populations exposed to radiation, such as atomic bomb survivors or radiotherapy patients, showed a significant increase of cancer risk at doses above 100 mSv. More recently, some epidemiological studies in individuals exposed to medical exposures during childhood (paediatric CT) suggested that cancer risk may increase even at lower doses (between 50-100 mSv). Children and foetuses are especially sensitive to radiation exposure. The cells in children and foetuses divide rapidly, providing more opportunity for radiation to disrupt the process and cause cell damage. Prenatal exposure to ionizing radiation may induce brain damage in foetuses following an acute dose exceeding 100 mSv between weeks 8-15 of pregnancy and 200 mSv between weeks 16-25 of pregnancy. Before week 8 or after week 25 of pregnancy, human studies have not shown radiation risk to fetal brain development. Epidemiological studies indicate that the cancer risk after fetal exposure to radiation is similar to the risk after exposure in early childhood.

3.4 Sources of Radiation

Background radiation is present on Earth at all times. The majority of background radiation occurs naturally from minerals and a small fraction comes from man-made elements. Naturally occurring radioactive minerals in the ground, soil, and water produce background radiation. The human body even contains some of these naturally-occurring radioactive minerals. Cosmic radiation from space also contributes to the background radiation around us. There can be large variances in natural background radiation levels from place to place, as well as changes in the same location over time.

3.4.1 Cosmic Radiation

Cosmic radiation comes from extremely energetic particles from the sun and stars that enter the earth's atmosphere. Some particles make it to the ground, while others interact with the atmosphere to create different types of radiation. Radiation levels increase as you get closer to the source, so the amount of cosmic radiation generally increases with elevation. The higher the altitude, the higher is the dose absorption of radiation. That is why those living in Denver, Colorado (altitude of 5,280 feet), USA, receive a higher annual radiation dose from cosmic radiation than someone living at sea level (altitude of 0 feet). Learn more about cosmic radiation in Rad Town USA, EPA's radiation education web area for students and teachers.

3.4.2 Radioactive Materials in the Earth and in Our Bodies

Uranium and thorium naturally found in the earth are called primordial radionuclide and are the source of terrestrial radiation. Trace amounts of uranium, thorium and their decay products can be found everywhere. Terrestrial radiation levels vary by location, but areas with higher concentrations of uranium and thorium in surface soils generally have higher dose levels. Traces of radioactive materials can be found in the body, mainly naturally occurring potassium-40. Potassium-40 is found in the food, soil, and water we ingest. Our bodies contain small amounts of radiation because the body metabolizes the non-radioactive and radioactive forms of potassium and other elements in the same way.

3.4.3 Man-Made Sources

A small fraction of background radiation comes from human activities. Trace amounts of radioactive elements have dispersed in the environment from nuclear weapons tests and accidents like the one at the Chernobyl nuclear power plant in Ukraine. Nuclear reactors emit small amounts of radioactive elements. Radioactive materials used in industry and even in some consumer products are also a source of small amounts of background radiation.

3.4.5 Nuclear Radiation

After over than 80 years of intensive scientific study, radiation is the most understood, easily detected, precisely measured and strictly regulated of all environmental agents. Radiation contributed by human technology is identical to naturally occurring radiation. Most of this radiation comes from X-rays and radioactive materials used in medicine. Mining, burning fuels and buildings also contribute to radiation doses. So does fallout from past testing of nuclear weapons, colour television and smoke detectors. The average dose per person from all sources is about 620 millirems per year. It is not, however, uncommon for any of us to receive far more than that in a given year, often due to medical procedures we may undergo. International standards allow exposure to as much as 5,000 millirems per year for those who work with and around radioactive material.

3.5 Remedy to Radiation Exposure

The following steps can prevent the risk of exposure to radiation:

- ✓ If you work around radioactive materials, it is important to have a radiation detector. Things change from day to day. Workers can forget to replace shielding around radiation sources. X-ray machines can be inadvertently activated. Things can get spilled. It is good to review your environment on a regular basis.
- ✓ Counting on a dosimeter can leave you vulnerable. Dosimeters generally tell you what dose you have received. While this may be useful for regulatory compliance and limiting your lifetime dose, it does not help you keep your dose minimised on a day to day basis.
- ✓ Use time distance and shielding to protect yourself. Putting distance and shielding between you and a radiation source is an effective way of reducing your exposure. Reducing the time you are being exposed to is another way.
- ✓ Use a respirator or face mask if you are exposed to airborne sources.
- ✓ Properly label sources and keep them shielded.
- ✓ Be thoughtful and be informed about medical X-rays. Medical imaging can provide important and lifesaving diagnostic information. It is also sometimes used unnecessarily. Sometimes the same diagnostic information can be obtained by using techniques that reduce dose. If you have concerns about the dose and benefits you may receive from a proposed procedure, take time to inform yourself and also have a conversation with your health care professional on/about any concerns you might have. If you continue to have reservations or concerns, you can always ask for a second opinion.
- ✓ Wear a wired headset for cell phones, or talk on a land line or speaker phone as much as possible in order to keep your cell phone away from your head.
- ✓ The use of microwaves is not recommended, but if still wants to use one occasionally for some reasons (there's always an alternative!). Check door gaskets regularly for leaks, and replace your oven every few years to minimize leakages.
- ✓ Use Ethernet instead of Wi Fi.

4.0 CONCLUSION

It can be concluded that light, heat, microwaves and wireless communications are all forms of radiation that are common around us. The four forms of ionizing radiation are alpha particles, beta particles, gamma rays, and, indirectly, neutrons. An alpha particle consists of two protons and two neutrons, the equivalent of the nucleus of a helium atom. A beta particle is an electron or a positron and is much lighter than an alpha particle. Ionizing radiation can be measured using units of electron volts, ergs, and joules. One joule of ionizing radiation can cause tens of thousands of trillions of ionizations. The majority of background radiation occurs naturally from minerals and a small fraction comes from man-made elements. It is the context in which those risks are put that helps us make a personal decision on whether we wish to take that risk. The personal risk from radiation at low doses is very small, but the fact that scientists are honest and say that it cannot be quantified with any certainty below a certain level of dose. Interestingly, most of us, including those who find risks from nuclear power unacceptable, will not even think about the risk of the dose of radiation we will experience from long-haul flights as we take off for our holidays, or when consenting to a medical procedure involving radiation.

5.0 SUMMARY

We have discussed the meaning of radiation and the sources from which they are emitted from as well as the unit scale used in measuring it. Radiation is one the environmental hazards that has bedeviled our environment. Man-made sources of radiation are the deadliest because it releases more into the environment that directly or indirectly affecting humans negatively. We are exposed to radiation on daily basis from both natural and man-made sources. Man-made sources of radiation are more detrimental. This unit has equipped us with the knowledge on how radiation can be minimized from affecting us. Even though we are exposed to various forms of radiation, if adequate care is employed the effects can be controlled.

6.0 TUTOR-MARKED ASSINGMENT

1. Outline the various forms of radiation.
2. Explain how radiation is measured.
3. As a knowledgeable student on radiation, suggest possible ways in which the effect of radiation can be minimised among nuclear industry workers.

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UNIT 2 OIL SPILL IN THE ENVIRONMENT, GAS FLARING AND CONTROL STRATEGY OF OIL DISASTER

CONTENTS

1.0 INTRODUCTION

The word "petroleum" means "rock oil" or "oil from the earth". Mankind has known petroleum or crude oil since the dawn of civilisation. It was used in ancient Persia and Burma, particularly as fuel for lamps. Burning of the natural gas (escaping from petroleum underground) gave the 'perpetual fire' at Baba Gurgur in Iraq. Gas flaring is one of the most challenging energy and environmental problems facing the world today, whether regionally or globally. It is a multi-billion dollar waste, a local environmental catastrophe and a global energy and environmental problem which has persisted for decades. In this unit, we are going to study the source, uses, impact, gas flaring and their remedy on our environment.

2.0 OBJECTIVES

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

- explain the term crude oil (petroleum)
- explain the source of crude oil
- describe the uses of crude oil
- explain effects of oil spill on the environment
- explain gas flaring
- describe the hazards associated with gas flaring
- know the control strategy on oil disaster related cases.

3.0 MAIN CONTENT

3.1 Source of Oil

Nelson (1954)wrote on two schools of thought on the origin and formation of petroleum. The first one is "The Organic Matter Theory", which suggests that petroleum was formed from the decomposition of dead marine organisms, like plankton. Compounds such as fats, which are very similar to hydrocarbons and even traces of certain hydrocarbons themselves, are present in virtually all forms of plant and animal life. This theory was supported by the finding that very recent marine deposits (10,000 to 15,000 years old) contain hydrocarbon and asphaltic material. Besides, there is a similarity between the molecular structures of some of the minor constituents of crude oil and those of compounds found in living organisms. Again, it is hard to see where else the carbon content of petroleum could have come from other than biological material, if indeed its origin is geologically fairly recent.

The more recent school of thought is the "Atmospheric Chemical Reaction Theory", which suggested that petroleum is very much older than the existence of life on the earth. The earth is over 5,000 million years old and at the point when it was a hot molten mass, consisting mainly of Hydrogen (H) and Carbon Dioxide (CO_2), chemical reactions between them formed a great range of hydrocarbons which rose to the atmosphere as vapour clouds similar to those suspected to surround the planet Venus today. As cooling of the earth preceded, condensation led to a 'petroleum-rain' that lasted 2,000 million years. Many valleys and basins collected the oil with its sediments. Much latter, water-rain came, on which the oil floats.

3.2 Effect of Oil Spill in the Environment

Even though petroleum products make life easier by their use in fueling airplanes, cars, trucks, cooking stoves and other applications in combustion engines, as well as in heating our homes, using them can cause environmental problems, like air and water pollution if not properly handled.

Figure 6: Effect of Oil Spill on the Aquatic Bird

3.2.1 Effect on Water and Land

Exploring and drilling for oil may disturb land and ocean habitats. A study on assessment of the impact of oil exploration activities on agriculture and natural resources in the Niger Delta Region of Nigeria showed that oil exploration activities adversely impacted specifically on soil/land resources, aquatic life/fisheries, water resources, crops, livestock and forests/vegetation. Oil spills have degraded most agricultural lands, reduced the availability of fish and fish products, caused the pollution of surface and ground water resources, destruction of arable and tree crops and death of farm animals in the region as a result of toxic materials in the soil and polluted water. Oil exploration activities have also resulted in the disappearance of some forest vegetation and animal species, including primates, fish, turtles and birds. The ultimate result of these impacts is a drastic reduction in farm productivity and animal farm income.

3.2.2 Atmosphere

When petroleum products are burned as fuel, they give off carbon dioxide (CO_2), a greenhouse gas that is linked with global warming. The use of petroleum products also gives off pollutants-Carbon monoxide (CO), nitrogen oxides, particulate matter and unburned hydrocarbons-that pollute the air humans breathe (Figure 7). Since a lot of air pollution comes from cars and trucks, many environmental laws have been aimed at changing the make-up of gasoline and diesel fuel so that they produce fewer emissions. These "reformulated fuels" are much cleaner burning than gasoline and diesel fuel.

Figure 7: Effect of Gas Flaring in the Environment

3.3 Gas Flaring

A large number of hydrocarbons are produced when waste oil-gas and oil-gas-water solutions are flared. Flaring is inefficient with combustion being most affected by ambient winds and heating value of the fuel. The efficiency of flares can be dependent on several factors like composition of the flare stream, flow rate of flare gases, wind velocity, ambient turbulence, presence of hydrocarbon droplets and water droplets in the flare stream.

Flaring is a high-temperature oxidation process used to burn combustible components, mostly hydrocarbons, of waste gases from industrial operations. Natural gas, propane, ethylene, propylene, butadiene and butane constitute 95% of the waste gases flared. In combustion, gaseous hydrocarbons react with atmospheric oxygen to form carbon dioxide (CO_2) and water. In some waste gases, carbon monoxide (CO) is the major combustible component. During a combustion reaction, several intermediate products are formed, and eventually, most of them are converted to CO_2 and water. Some quantities of stable intermediate products such as carbon monoxide, hydrogen, and hydrocarbons will escape as emissions.

The quantity of hydrocarbon emissions generated is dependent on the degree of combustion. Theoretically, the combustion processes with complete combustion create relatively innocuous gases such as carbon dioxide and water. However, because the flaring efficiency depends on wind speeds, stack exit velocity, stoichiometric mixing ratios, and heating value, the flaring in reality is rarely successful in the achievement of complete combustion. Reduced combustion efficiency must be regarded as the norm in any operations with flaring.

3.4 Control Strategy of Oil Disaster

Gas flaring contributes to climate change, which has serious implications for the world. Gas flaring is a major source of greenhouse gases (GHG) contributing to global warming which could accelerate the problem of climatic change and harsh living conditions on earth, if not checked.

3.4.1 Simulation of Oil Cleaning Spill in Water and Land

The desirable properties of an oil spill simulant vary depending upon the goals of the oil spill exercise. If the oil spill simulant is to be used to test the logistics of a spill response group, then the oil spill simulant should possess the macro properties of oil. That is to say it should float and migrate (travel) similar to oil. If the technical containment and recovery aspects of oil spill response are to be tested, then the simulant must possess the micro properties of oil, such as viscosity, density, interfacial tension and emulsion formation properties. As can be gleaned from the preceding, it is much easier to develop an environmentally friendly oil spill simulant that mimics the macro properties of oil than to develop an environmentally friendly oil spill simulant that displays the micro properties of oil. In other words, it is the micro properties that define the oil and how the oil behaves. Even these properties can vary between different types of crude oils, therefore the development of a single oil simulant is difficult, let alone an environmentally friendly simulant.

Cleaning contaminated soil is not an easy process and needs time to get clean. The remediations that can be used as on-site contamination are: soil vapor extraction, Pump and Treat Systems, Degradation, and Bioremediation. Soil vapor extraction is the technique in which contaminates present in the soil are made to vaporise at the soil temperature only by applying vacuum in soil. This creates pore spaces and increases the air flow in soil. That is why this process is also called vacuum extraction, or enhanced *in situ*volatilisation. Contaminates are sucked by the vacuum blower in gaseous form through a vapor extraction well which is further transported for separator.

Pump and treat system is a very usual technique which is used for remediation. In this method, the pumping well is drilled which brings out the contaminated water to the surface which is further treated in surface water facilities. The water that is obtained after treatment can be reused or is supplied for use. The further treatment depends on the kind of contaminants present in the groundwater. If non-aqueous phased liquid is present, then phase separation is done by adding other pumping units. This technique can also be used with vapor extraction technique.
Degradation remediation is of two types: a) chemical degradation and b) biological degradation. In chemical degradation, neutralisation of the contaminants is accelerated by using chemicals and transforming them into a state which is less harmful. These chemicals oxidise the metals and reduce the oxidation state of contaminants while in biological degradation, the organic reagents work as a chemical entity like in chemical degradation. It is a type of bioremediation technique which converts the hydrocarbon present in soil into carbon dioxide, water and harmless products.

3.4.2 Control of Gas Flaring

Several studies over the past years have evaluated flare efficiencies. These include major flare research programs by the US EPA, the Alberta Research Council, and the University of Alberta. Other work includes a CMA study; surveys of operating flares by BP/Statoil, the German Aerospace Centre and Shell in Europe, and Shell Nigeria; and a multi-year Petroleum Environmental Research Forum (PERF) study of external combustion. These studies have consistently shown that appropriately designed and operated flares are highly efficient, converting 98%-99.5% or more of the hydrocarbon feed to carbon dioxide and water. The Large Eddy Simulation of a real appliance for the flaring of the gases coming from an oil well were conducted with results that, both qualitatively and in terms of global efficiency, agree satisfactorily with those expected. The results provided useful information for a better design of confined flare.

4.0 CONCLUSION

In this unit, we were able to learn the two fundamental theories that surround the deposition and formation of petroleum, as well as the negative consequences of oil exploration on the soil, water and air. Petroleum has rendered the soil and water unfit for use in area that is been explored and by extension the atmosphere. In that regard, we were able to outline the control measures that can prevent or minimize the negative impact on our environment.

5.0 SUMMARY

Nelson wrote on two schools of thought on the origin and formation of petroleum. The first one is "The Organic Matter Theory" and "Atmospheric Chemical Reaction Theory". Petroleum exploration has adverse effect on water, land and atmosphere. Aquatic and soil organisms are been exterminated as a result of mindless exploration of petroleum, while the waste products inform gaseous emission it is destroying the ozone layer. The effect of destruction of ozone layer from emissions causes the global warming we experience today. Environmental contamination through gas flaring is a major source of greenhouse gases (GHG) that contributes to global warming, which could accelerate the problem of climatic change and harsh living conditions on earth, if not checked. The effect of gas flaring can be remedied through simulation of oil cleaning spill in water and land, as well as Eddy simulation of a real appliance for the flaring of the gases coming from an oil wells. Also regulatory agencies can minimize the effect through enforcement of rules that govern flaring gas.

6.0 TUTOR-MARKED ASSIGNMENT

1. Write a comprehensive note on the school of thoughts on the origin and formation of petroleum.
2. What is the negative implication of the oil exploration in the oil-rich states in Nigeria?
3. Highlight the impact of gas flaring on the environment.
4. Outline the process of controlling gas flaring in the environment.

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UNIT 3 ENVIRONMENTAL IMPACT ASSESSMENT, AUDIT AND STATEMENT

CONTENTS

1.0 INTRODUCTION

Environmental Impact Assessment Review (EIA)is a refereed, interdisciplinary journal serving a global audience of practitioners, policy-makers, regulators, academics and others with an interest in the field of impact assessment (IA) and management. Environmental Impact Assessment (EIA) is the regulatory process within 190 of 193 member states of the United Nations to prevent and mitigate the potential environmental impacts of industry development projects before these occur. Despite the several sectorial regulations aimed at moderating and controlling environmental degradation which and are unsuccessful due to the absence of effective sanctions. Economic considerations and fundamental lack of knowledge of interdependent linkages among development processes and environmental factors, as well as human and natural resources, resulted in an unmitigated assault on the environment. The use of environmental audit and environmental statement help in evaluating the magnitude of the danger posed on the environment.

2.0 OBJECTIVES

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

- understand the concepts of environmental impact assessment
- explain the act that established eia
- understand the role of law enforcement agents in eia
- define audit and understand its application
- know the methods involved in environmental audit
- know the use of Environmental Statement in handling environmental challenges.

3.0 MAIN CONTENT

3.1 Techniques in Environmental Impact Assessment (EIA)

Environmental Impact Assessment (EIA) has been adopted as an environmental management and planning tool by many developed and developing countries after its introduction in the United States in the late 1960s. The EIA can be defined as a systematic process for identifying, predicting and evaluating potential impacts associated with a development project. The EIA process must proffer mitigation measures to avoid, reduce or minimise the negative impacts on the environment, public health and property. It must also enhance positive impacts. The mitigation measures entail identifying possible alternative site, project, process design, including that of not proceeding with the project. EIA is not a one – off process which terminates in the production of a report on the effects of the project and associated mitigation measures. It also deals with monitoring the construction and operational phases, and acting on the results of such monitoring till final closure.

The post-closure care is also an integral part of the EIA process. Many EIA systems are built on the original 1969 National Environmental Protection Act (NEPA) in the United States, which explicitly included the words 'human health'. Nigeria, for example, is a Lower Middle Income Country (LMIC) whose EIA system contains similar wording. Despite this, influencing the actual functioning of these systems, including under NEPA to comprehensively incorporate health has, however, proven challenging and remains a missed opportunity for public health. The EIA legislations and the required procedural guidelines for carrying out the EIA process became effective since the 1970s in developed countries. Nigeria took a giant leap when she promulgated her main EIA legislation (i.e. EIA Act No.86) in 1992 (6).The Nigerian EIA Act No. 86 of 1992 (8) makes the EIA mandatory for development projects likely to have adverse impacts on the environment prior to implementation {Section 14(1) (a) & (b)}. Section 14 (1) (d) further states that the Federal, States, Local Councils or any of its agencies, prior to environmental assessment of the project in accordance with the EIA Act, shall not "under the provisions of any law or enactment, issues a permit or license, grants an approval or takes any other action for the purpose of enabling the project to be carried out in whole or in part."

3.2 Role of Stakeholders in EIA

The environmental stakeholders are under moral and legal obligations to protect and enhance the natural environment. They can do this by combating destructive environmental projects; promoting environmental sustainability of natural resources, good environmental policy/practice; and striving for environmental justice. The environmental stakeholders include the government regulators, the projects proponents, the local communities, the non-governmental organisations (NGO's) and the general public. In essence, everyone is a stakeholder in the environment. The government has a major role to play in providing a national framework for integrating development and conservation. The government should:

- Establish a comprehensive system of environmental law and provide for its implementation and enforcement by all stakeholders.

- Review the adequacy of legal, political and administrative controls concerning implementation and enforcement mechanisms, recognizing the local approaches.
- Ensure that national policies, development plans & programs, budgets and other decisions take full account of their effects on the environment.
- Use economic incentive or disincentive as appropriate to achieve sustainability.

In Nigeria, the EIA regulations are principally contained in the EIA Act No. 86 of 1992. The law is administered by Federal Ministry of Environment, Housing & Urban Development (FMEH&UD). But in practice the law stands 'abrogated', as it has not been rightly enforced by the regulator since its commencement. This is due to lack of technical resources by the government regulatory body on the one hand and the considerable leverage of the operators of projects (with potential hazards) over the regulator on the other hand. Both the regulator and operators often engage in pretend game at the expense of the local communities. The multinational oil and gas industry gives itself moral and legal authority to regulate its own activities and also dictates to the government agencies regarding the regulatory regime. This enables the law to be prostituted to the greedy oil and gas industry. Consequently, the multinational views collaboration with local communities as an undue burden on it rather than a means to develop a productive rapport with its social environment.

EIA is mandatory for activities in all sectors of the economy. The activities in the oil and gas sector for example which require an EIA include:

a) Oil and gas fields' development;
b) Construction of off-shore, on-shore, and overland pipe line;
c) Construction of oil and gas processing facilities;
d) Construction of oil refineries;
e) Waste treatment and disposal.

3.3 Environmental Audit

The term 'audit' has it origin in the financial sector. Auditing in general is a methodical examination involving analyses, tests and confirmations of procedures and practices whose goal is to verify whether they comply with legal requirements, internal policies and accepted practices. It can also be said that a systematic, documented, periodic, and objective review of facility operations and practices related to meeting environmental requirements is referred to as environmental audit. The policy also identified several objectives for audits:

✓ Verifying compliance with environmental requirements;
✓ Evaluating the effectiveness of in-place environmental management systems; and
✓ Assessing risks from regulated and unregulated materials and practices.

There are few key elements that absolutely should be a part of every audit.

i. Systematic: Following some type of auditing program, using standard practices, done comprehensively, providing for that "head to toe" type review. Basically, following rules about how to do the audit and not just winging it.
ii. Documented: The audit is recorded mostly via writing or on a computer or via software. The findings are documented, and kept track of it.
iii. Periodic: This means that the audits are done regularly, not just once. This is subjective as your audits could be bi-annually, annually, every other year, every fiveyears, etc.
iv. Objective: The audit is performed by someone without a vested interest in the outcome. So, if you are an environmental manager, your job is to pay, or position depends on the finding of the audit he/she is conducting, it's not objective**.** This is basically saying to have an outsider do the audit.
v. Verifying compliance: Ensuring you are in compliance with every rule and regulation which applies to the operation or facility, and all facets of those regulations. Not just picking and choosing, electing to ignore the ones you are not sure about or know you are not in compliance with. It means you are on the same level with every applicable federal, state, and possibly even local government and city regulations that apply to the environmental issues.

3.4 Environmental Impact Statement

The Environmental Impact Statement (EIS) is a document prepared by a proponent or developer applicant describing a proposed program or project; alternatives to the project and measure to be adopted to protect the environment.

The EIS shall include a description of the likely significant effect, direct and indirect, on the environment of the development, explained by relevance to its possible impact on historical, archaeological, cultural heritage.

Characteristics of an Environmental Impact Statement (EIS)

- Clear, concise summary
- Full glossary
- Contents and authorship clearly set out
- Brief history of proposed development
- Full description of the proposed project, objectives, geographical boundary, short and long term impacts, reversible or permanent impacts
- Full description of existing environment - data assembly
- Alternative actions - the no-action alternative
- Justification of proposal - economic, social and environmental
- Proposal for protection of the environment from proposed actions - risks and mitigation actions for components of the system failing
- Effect on local infrastructure
- Communication - full involvement of the public
- The decision - public release of the decision

4.0 CONCLUSION

Environmental Impact Assessment (EIA) has been adopted as an environmental management and planning tool by many developed and developing countries to handle environmental challenges. The importance of EIA cannot be overemphasised because is a major problem that threatens the existence of human. The environmental stakeholders in particular and by extension everyone is under moral and legal obligations to protect and enhance the natural environment. Environmental impact statement (EIS) is a planning tool intended to identify and mitigate significant adverse environmental effects of projects. Environmental impact assessment (Audit and statement) is the process of identification, description and assessment of the direct and indirect effects of a project on: human beings, fauna and flora; soil, water, air, climate and the landscape; the interaction of these factors; and on material assets, and the cultural heritage.

5.0 SUMMARY

Environmental hazard means one or a group of toxic chemical, biological, or physical agents in the environment, resulting from human activities or natural processes, that may impact the health of exposed individual, including such pollutants as lead, pesticides, air pollutants, contaminated drinking water, polluted waters, toxic waste, polychlorinated biphenyls, secondhand tobacco smoke, and industrial and home chemicals. Environmental audit has some essential elements such as systematic, documentation, periodic, objectives and verifying compliance that guide the specialist. On the other hand, EIS includes a description of the likely significant effect, direct and indirect, on the environment.

6.0 TUTOR-MARKED ASSIGNMENT

1. Define EIA and outline how it came into existence.
2. Briefly outline characteristics of environmental impact statement.
3. In details, describe essential elements of environmental audit.

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UNIT 4 REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM IN ENVIRONMENTAL HEALTH

CONTENTS

1.0 INTRODUCTION

Remote sensors remotely interact with objects on the surface of the Earth. Objects on the surface of the earth generally include terrain, buildings, road, vegetation, and water. The typical materials of these objects that interact with the EMS are categorised into groups: transparent and opaque (partly or fully absorbed). Geographic information systems (GIS) are "automated systems for the capture, storage, retrieval, analysis, and display of spatial data". Common to all GIS is a realisation that spatial data are unique because their records can be linked to a geographic map. The component parts of a GIS include not just a database, but also spatial or map information and some mechanism to link them together. It has also been described as the technology side of a new discipline, geographic information science, which in turn is defined as "research on the generic issues that surround the use of GIS technology, impede its successful implementation, or emerge from an understanding of its potential capabilities."

2.0 OBJECTIVES

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

- explain how remote sensor operates
- know the application of remote sensing based on distance
- differentiate the types of sensors
- explain the interaction between object and spectrum
- list the function of space-borne sensor
- explain what GIS is?
- describe the gis and its technology
- describe the application of gis in environmental solutions.

3.0 MAIN CONTENT

3.1 Electromagnetic Spectrum (EMS)

In remote sensing, typical applications include the visible light (380–780 nm), infrared (780 nm–0.1 mm), and microwave (0.1 mm–1 m) ranges. Remote sensing sensors interact with objects remotely. Between sensors and the earth surface, there is the atmosphere. It is estimated that only 67% of sunlight directly heats the earth. The remaining light is absorbed and reflected by the atmosphere. The earth's atmosphere strongly absorbs infrared and ultra-violet (UV) radiation. In visible light, typical remote sensing applications include the blue (450–495 nm), green (495–570 nm), and red (620–750 nm) spectral bands for panchromatic or multispectral or hyper-spectral imaging.

The absorption coefficient for water is approximately an order of magnitude smaller than at 532 nm, and 420–460 nm light can penetrate relatively clear water and ice much deeper, offering substantial improvements in sensing through water for the same optical power output, thus reducing power requirements. The red spectrum together with near-infrared (NIR) is typically used for vegetation applications. For example, the Normalised Difference Vegetation Index (NDVI) is used to evaluate targets that may or may not contain live green vegetation. Infrared is invisible radiant energy. Usually, infrared is divided into different regions: near IR (NIR, 0.75–1.4 μm), shortwave IR (SWIR, 1.4–3 μm), mid-IR (MIR, 3–8 μm), longwave IR (LWIR, 8–15 μm), and far IR (FIR, 15–1000 μm).

Alternatively, according to the ISO 20473 scheme, another division is proposed as NIR (0.78–3 μm), MIR (3–50 μm), and FIR (50–1000 μm). Most of the infrared radiation in sunlight is in the NIR range. Most of the thermal radiation emitted by objects near room temperature is infrared. In nature, on the surface of the earth, almost all thermal radiation consists of infrared in the mid-infrared region, which is a much longer wavelength than that in sunlight. Of these natural thermal radiation processes, only lightening and natural fires are hot enough to produce much visible energy, and fires produce far more infrared than visible light energy. NIR is mainly used in medical imaging and physiological diagnostics. One typical application of MIR and FIR is thermal imaging, for example, night vision devices. In the MIR and FIR spectrum bands, water shows high absorption, and biological systems are highly transmissive.

3.2 Objects and Spectrum

When light encounters an object, they can interact in several different ways. The interaction could inform of transmission, reflection, and absorption. The interaction depends on the wavelength of the light and the nature of the material of the object. Most materials exhibit all three properties when interacting with light. It may partly transmission, partly reflection, and partly absorption. According to the dominant optical property, objects have been categorized into two typical types as transparent materials and opaque materials. Transparent material allows light to pass through the material without being scattered or absorbed. Typical transparent objects include plate glass and clean water. Opacity occurs because of the reflection and absorption of light waves off the surface of an object. The reflectance of light depends on the material of the surface that the light encounters. Representative reflective materials include metals, such as aluminum, gold, and silver.

The physical characteristics of the material determine what type of electromagnetic waves will and will not pass through it. For example, reflection of dry bare soil increase as the wavelength increases from 400 to 1800 nm. Green vegetation has a high reflectance in the red light and near-infrared regions. These characteristics have been applied for distinguishing green vegetation from other objects. In addition, water has a low absorbance in the visible light region.

3.3 Space-borne Sensor

Space-borne sensors have been developed for over 40 years. Currently, approximately 50 countries are operating remote sensing satellites. There are more than 1000 remote sensing satellites available in space, and among these, approximately 593 are from the USA, over 135 are from Russia, and approximately 192 are from China. Conventionally, remote sensors are divided into two groups as passive sensors and active sensors. For example, an imaging camera is usually regarded as a passive sensor. In 2013, a new approach that integrates active and passive infrared imaging capability into a single chip was developed. This sensor enables lighter, simpler dual-mode active/passive cameras with lower power dissipation. Alternatively, remote sensing sensors can be classified into imaging sensors and non-imaging sensors. In terms of their spectral characteristics, the imaging sensors include optical imaging sensors, thermal imaging sensors, and radar imaging sensors. Thermal sensor typically operates in the electromagnetic spectrum especially useful in tracking a living creature, including animals and the human body, and detecting volcanos and forest fires. Thermal image is independent from the lights in a scene and is available whether it is daytime or nighttime.

3.4 Concept of GIS

A Geographical Information System (GIS) is a computer system for processing, storing, checking, integrating, manipulating, analysing and displaying data related to positions on the surface of the earth. It is then presented cartographically, graphically or as a report. Most GIS users add to the specialised software, procedures, operating staff and also the spatial data that feed the system. To locate geographical information on a map, it is either maps that use a coordinate system to allow locations to be read, or the shapes (polygons) of the geographic information are used, where shapes of the features and themes are drawn onto the map. Applications of GIS could reveal links between different sources of information, when it is presented on a map and can find out relationships between features that are not readily apparent in spreadsheets or statistical packages.

The strength of a GIS is related to its ability to relate different information into a spatial context and to reach a conclusion about this spatial relationship that cannot be seen if the information is looked at independently. Therefore, it is used to determine where or what an individual feature is and to help in finding patterns by looking at the distribution of overlapped features on the map instead of just a set of individual features not linked together.

3.5 Role of GIS in Environment

Geographical Information System (GIS) can relate otherwise disparate information, on the basis of common geography, revealing hidden patterns, relationships, and trends that are not readily apparent in spreadsheets or statistical packages, often creating new information from existing data resources. This information is very important as a management tool and produces valuable information needed for better decision making. The applications of GIS are very wide and are used in all human activities. It is used for marketing studies, telecommunications, location of restaurants, museums and hospitals; in tracking trucks traffic; in establishing maps of animal population density by species or maps of vegetation coverage change; in locating forests, rivers, and mountains, in determining soil compositions, etc.

Furthermore, GIS is an excellent tool for spatial data presentation, inclusion of additional layers (e.g. environmental factors) for better analysis. It is an excellent tool for decision making not yet implemented or used by many in Veterinary and Medical Services around the world. The understanding and explaining disease dynamics and spreading patterns is also assessed using GIS. It helps increasing the speed of response in case of an emergency linked with the introduction of a disease. Overlapping maps of location of outbreaks with the map of location of farms, abattoirs or roads, for example, can help better drawing the perimeter of security, surveillance zones as well as available facilities to implement the decided control measures. The addition of other factors, such as the Normalised Difference Vegetation Index (NDVI), satellite images and vectors distribution in case of vector-borne diseases, can correlate disease trends and be used as an early warning tool, for example, or for the prediction of the evolution of a newly introduced disease. The availability of up-to-date data on the location of farms, poultry premises, roads, etc., prior to an emergency can help in implementing disease control measures, surveillance activities including control of the movements of vehicles, etc. The existence of digital data locating abattoirs, mines, incinerators, etc, can ease destruction of susceptible animals, if stamping out or modified stamping out is to be implemented to combat the introduction of a disease.

4.0 CONCLUSION

This unit has showed that the earth's atmosphere strongly absorbs infrared and ultra-violet (UV) radiation. In visible light, typical remote sensing applications include the blue, green, and red spectral bands for panchromatic or multispectral or hyper-spectral imaging. In addition, a typical application of MIR and FIR is thermal imaging, for example, night vision devices. In the MIR and FIR spectrum bands, water shows high absorption, and biological systems are highly transmissive. Geographic information system in Environmental Health is useful as an excellent tool for decision making not yet implemented or used by many in Veterinary and Medical Services around the world. The strength of a GIS is related to its ability to relate different information into a spatial context and to reach a conclusion about this spatial relationship that cannot be seen if the information is looked at independently. Therefore, it is used to determine where or what an individual feature is and to help in finding patterns by looking at the distribution of overlapped features on the map instead of just a set of individual features not linked together.

5.0 SUMMARY

Remote sensors remotely interact with objects on the surface of the earth. The use of EMS in remote sensing is typically applied in visible light, infrared, and microwave ranges. Alternatively, according to ISO 20473 schemes, another division are proposed as NIR, MIR and FIR. Most of the infrared radiation in sunlight is in the NIR range. Objects and spectrum interaction could be informing of transmission, reflection, and absorption. The physical characteristics of the material determine what type of electromagnetic waves will and will not pass through it. There are more than 1000 remote sensing satellites available in space, and among these, approximately 593 are from the USA, over 135 are from Russia, and approximately 192 are from China. An automated system for the capture, storage, retrieval, analysis, and display of spatial data is achieved through the use of GIS. The strength of a GIS is related to its ability to relate different information into a spatial context and to reach a conclusion about this spatial relationship that cannot be seen if the information if looked independently.

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss the principle(s) behind objects and spectrum.
2. Briefly describe techniques in GIS as it relates to the environment.
3. Justify the statement that says "GIS is a breakthrough in controlling diseases in medical services"

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