NATIONAL OPEN UNIVERSITY OF NIGERIA

SCHOOL OF SCIENCE AND TECHNOLOGY

COURSE CODE: BIO 411

COURSE TITLE: PARASITOLOGY

BIO 411 PARASITOLOGY **2 UNITS**

MODULE 1:

Unit 1: The concept and scope of Parasitology

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Module 1:

Unit 1: The concept and scope of Parasitology

Content

1.0 Introduction

Parasites are living things which harm udders by becoming metabolically dependent on them. It is an old animal relationship based on the concept of dependence for nutrition and support. Parasitology is current studied in a wide variety of headings and it is a dynamic aspect of zoology with links to other fields of sciences and social sciences.

2.0 Objectives

At the end of the lesson, the student should be able to clearly identify an animal that is a parasite, the branches of parasitology and its scope. Also the student must be able to focus slides under different objectives and estimate disease prevalence

3.0 Main Content

3.1 Parasitology

No biological association is of greater medical importance than parasitism. Parasites plague humanity and are at the root cause of many diseases especially in the tropics, the need for a dedicated branch of Zoology to study these exciting but disturbing polyphyletic animal groups.

Parasitology is the study of parasites, their hosts, and the relationship between them. It is an applied field of biology dedicated to the study of the biology, ecology and relationships which parasites are involved in with other organisms known as the host.

3.2 Branches of Parasitology

Depending on the specific bias, there are different fields of parasitology and some of these include medical parsitology, veterinary parasitology, structural parasitology, quantitative parasitology, parasite ecology, conservation of parasites, malariology, helminthology parasite immunology etc.

3.2.1 Medical Parasitology

This is the science that deals with organisms living in the human body (the host) and the medical significance of host-parasite relationship. It's also concerned with the various methods of their diagnosis, treatment and finally their prevention and control.

3.2.2 Veterinary parasitology

The study of parasites that cause economic losses in agriculture or aquaculture operations, or which infect companion animals. This is becoming particularly important as emerging diseases threatens global food security. In Nigeria, a number of studies have been conducted in fish parasitology and other vertebrates such as Lizards and Cats with Zoonotic potential.

3.2.3 Structural parsitology

This is the study of structures of proteins from parasites. Determination of parasitic protein structures may help to better understand how these proteins function differently from homologous proteins in humans. In addition, protein structures may inform the process of drug discovery.

3.2.4 Quantitative parasitology

Parasites exhibit an aggregated distribution among host individuals, thus the majority of parasites live in the minority of hosts. This feature forces parasitologists to use advanced biostatistical methodologies.

3.2.5 Parasite Ecology

Parasites can provide information about host population ecology. In fisheries biology, for example, parasite communities can be used to distinguish distinct populations of the same fish species co-inhabiting a region. Additionally, parasites possess a variety of specialized traits and life-history strategies that enable them to colonize hosts. Understanding these aspects of parasite ecology, of interest in their own right, can illuminate parasite-avoidance strategies employed by host

3.2.6 Malariology

This is an aspect of parasitology which focuses mainly on the study of Protozon parasite, *Plasmodium,* its species, their biology, pathogenicity, epidemiology and management of the parasitic infection.

3.2.7 Helminthology

“Helminth” means worms. Hence as the name implies it is the study of vermiform parasites ranging from trematodes to Cestodans, Nematodans and leeches.

3.2.8 Parasite Immunology

This is an aspect which deals with parasite survival in host as well as host susceptibility. This aspect is particularly important when formulating concentrations of chemotherapeutic agents and vaccines.

3.3 The scope of Parasitology

As a biological discipline, the scope of parasitology is not determined by the organism or environment in question, but by their way of life. This means it forms a synthesis of other disciplines, and draws on techniques from fields such as cell biology, bioinformatics, biochemistry, molecular biology, immunology, genetics, evolution and ecology.

Thus parasitology covers a wide range of topics which centre around parasites, their taxonomic positions, their structural and physiological biology, life cycle patterns, ecology, pathenogenicity, diagnosis of infection as well as management with chemotherapy and other contemporary techniques.

4.0 Conclusion

Parasitology has become an established branch of Applied Zoology which has been able to integrate with other branches of sciences as well as social sciences in managing parasitic diseases world over.

5.0 Summary

- Parasites are a polyphyletic group of animals ranging from protozoans to chordates
- They are responsible for a number of diseases and mortality in their hosts which includes humans.
- In other to properly reflect the complex interactions of parasites and their host, they are studied under diverse branches.

7.0 Tutor Marked Exam

a. State the different kinds of microscope and their uses

b. Draw a microscope and state the uses of its parts

c. Define parasitology and write short notes on any five branches of parasitology

7.0 References/Further reading

Otubanjo, O.A. (2008) Elements of Parasitology Second Edition. Panaf Publishing Inc. Abuja 196pp

Ukoli, F.M.A. (1990). Introduction to parasitology in Tropical Africa. Texflow Limited, Ibadan. 462pp.

Module 1

Unit 2: The concept of epidemiology and Parasitic Disease transmission

Module 1

Unit 2: The concept of epidemiology and Parasitic Disease transmission

Content

1.0 Introduction

Parasites are dynamic in their distribution-some are endemic while many are ubiquitous. The environment plays a key role in their survival and transmission. Often times, they rely of vectors (mostly arthropods) for their transmission.

2.0 Objective

At the end of the class, student must have fully understood, the distribution of parasites and their general effects on biological systems and disease transmission patterns. The student should also be calculate the prevalence of diseases.

3.0 Main content

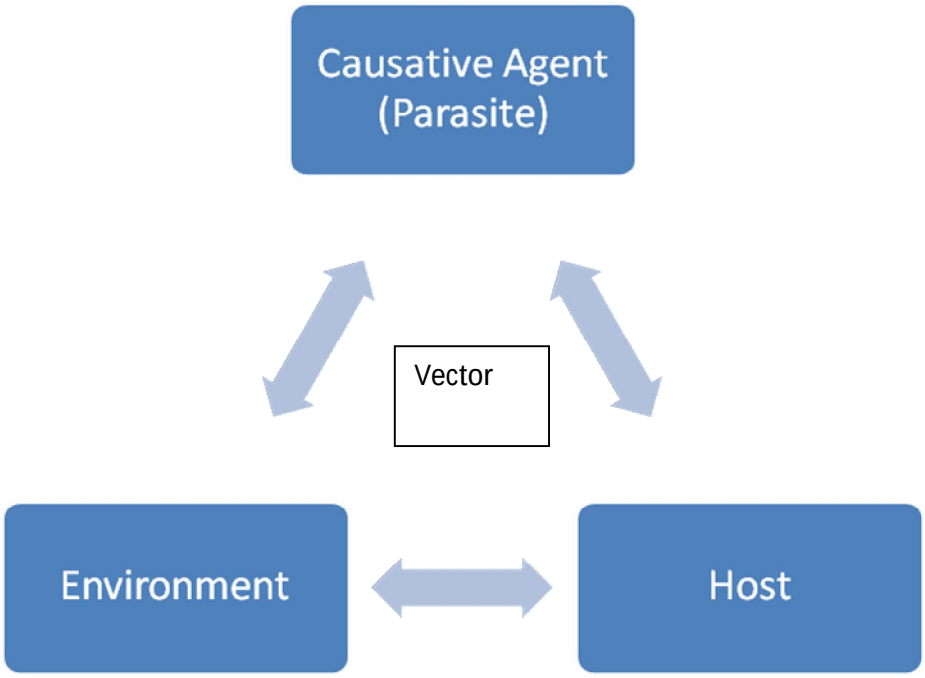
3.1. Parasitic Disease transmission
3.2. The concept of epidemiology

3.1 Parasitic Disease transmission

By virtue of their nature, parasites reside in their hosts, depend on their hosts for physiological and nutritional ends and hence often result in adverse effects on their host.

The parasite-host interaction does not occur in isolation; rather it is affected by conditions known as risk factors. A risk factor which must occur for a disease situation to arise is known as the necessary risk while the organism/parasite which causes the disease is called an agent.

The causal web is a simple triangle which shows the inevitable link between the agent (parasite), the host and the environment. Often times especially with parasitic infections, there may be a vector which links all components as shown below.



Thus a number of factors predisposes a host to attack by a vector, affects vector viability and life cycles and even how the host respond to parasitic infections/diseases. All these add up into the concept of Epidemiology.

3.2 The concept of epidemiology

Epidemiology is the study of the disease pattern and distribution, within a defined community or population.

It is derived from the combination of Greek words Epi which means upon, demos which means people and logy which means study.

It is an interdisciplinary subject, involving medicine, science, geography and statistics. Epidemiology is a quantitative science that evaluates the occurrence, distribution, determinants of control of disease pattern in a defined population. Thus in epidemiology, demographic and social characteristics of the host such as population density, poverty etc. are important attributes in epidemiological studies. Physical, biological, sociological and psychological variables are significant determinants of disease distribution and patterns. They are considered as extrinsic factors. Demographic and social attributes of the definitive host are significant factors in disease manifestation. The demographic factors include:

- Age
- Sex,
- Race,
- Population density etc.

Thus epidemiology is a scientific enquiry on disease occurrence. i.e the study of disease distribution and its determinants. The unit of the study of epidemiology is a defined or identifiable population. A population in this context is not always defined by geographical

boundries rather by a number of other factors such as age, sex, occupation, ethnicity, religion, institution, etc.

Epidemiology is therefore the study of disease occurrence in populations- humans, plants, animals.
It is indeed an analytical arm of community and preventive medicine, utilizing statistics as a working tool. It is integral to the management of public health and it aims to improve the health of the population.

The aims of epidemiology includes to :

- Determine the primary agent or ascertain causative factors
- Understand the causation of disease, disorders or conditions
- Determine the characteristics of the agent or causative factors
- Define the mode of transmission
- Define and determine contributing/confounding factors
- Identify and explain geographic disease patterns
- Determine, describe and report the natural cause of disease, disability, injury and/or death
- Determine suitable control measures
- Determine preventive measures
- Aid in planning and development of health services and
- Provide administrative and planning data in public health management.

4.0 Conclusion

The parasitic disease triad incorporates the agent (parasite), host and the environment as the key determinants of parasitic disease transmission.

5.0 Summary

6.0 Tutor Marked Assignment (TMA)

a. Draw the disease triad and use it in explaining parasitic disease transmission

b. Design an epidemiological methodology for assessing malaria disease prevalence.

7.0 References/Further reading

Otubanjo, O.A. (2008) Elements of Parasitology Second Edition. Panaf Publishing Inc. Abuja 196pp.

Module 1

Unit 3: Measure of Epidemiology and Disability Adjusted Life Years (DALY)

Module 1

Unit 3: Measure of Epidemiology and Disability Adjusted Life Years (DALY)

Content

1.0 Introduction

Epidemiological estimates have become important at local, national and international scales for the provision of health statistics for the purpose of budgeting and forecasting. Hence a set of statistical indices have been evolved to meet this end. This has been coupled with new innovative techniques which involves the use of Rapid assessments (e.g RAPLOA,REMO), Remote sensing (RS) and Geographic Information Systems (GIS).

2.0 Objectives

At the end of the class, student must be familiar with the terms Prevalence, incidence, intensity, disease burden and DALYs , DALY estimates for different parasitic diseases and how to estimate them.

3.0 Main Content

3.1 Measure of Epidemiology

There are a number of tools for measurement or description in epidemiology. These include:

- Prevalence: frequency of a disease at a particular time. Based on prevalence a disease may be defined as endemic (maintain a relatively constant but moderate level of occurrence), Hyper- endemic (persistently high and continuous level of occurrence), epidemic (an outbreak or sudden occurrence of a disease with considerable intensity) or Holoendemic (high prevalence amongst children in a population).
- Epidemiological rate- morbidity rate, mortality rate, incidence rate, admission rate etc.
- Disease Burden (overall weight of effect of a disease) using DALY.
- Estimation of disease intensity using direct parasite count, indirect counting of eggs and cysts in faeces, indirect measurement of levels of immunological responses to parasite antigens.
- Parasite dispersion estimation which may be under dispersion, random or over dispersion.
- Geographical distribution estimation using mapping techniques such as mnual cartographic maps, geographic information system and remote sensing.

Epidemiological studies may be descriptive, analytical (cohort, or case control), experimental or rapid epidemiological assessment.

3.2 Disability Adjusted Life Years (DALYs)

In epidemiology, the disease burden on the economy is approached from the view that morbidity from parasitic infection impairs productivity as a result of loss of valuable man- hour. This is calculated using an index known as the Disability adjusted life years (DALYs).

DALYs is an health indicator which translates disabilities into years of healthy life lost, by giving each disease state a disability weight ranging from zero (healthy) to 1 (death). It incorporates the potential years of lost life as a result of death at a given age. It measures the burden of a disease of a defined population and the effectiveness of interventions. They are valid indicators of population heath.

In summary, DALYs can simply be defined as the number of health years of life lost due to premature death or disability.

3.2.1 DALYs estimate of Common Parasitic Diseases

The table below shows the global estimates of parasitic disease effects using the DALYs tool.

Table 1: Global estimates of some parasitic diseases (WHO, 2002)

Disease	TDR Disease Category	DALYs (hundreds of thousands)			Deaths (Thousands)			Pop. At risk millions	No of endemic countries	No. of infected prevalence
		Total	Male	female	Total	Male	female			
African trypanosomiasis	1	1,598	1029	568	50	32	18	50m	36	>300,000
Leishhmaniasis	1	2357	1410	946	59	35	24	350	82	12m

								m		
Malaria	2	42280	2002 4	2225 6	112 4	532	592	200 m	90	300-500m

The burden of various diseases over time, depends on many factors. Presently, some disease burdens have continued to increase. For instance, increasing malaria burdens occur in some countries of Africa due to factors such as drug resistance, frequent exposure of the non-immune populations, the emergence of HIV/AIDS, climatic and environmental changes and the breakdown of control programmes. Such increased parasite burden results in increased economic burden of the population.

The economic burden of a disease is the totality of direct and indirect costs associated with the infection. These include morbidity, loss of productivity, absenteeism and cost of health care in the infected people, as well as the losses in agriculture and non- agricultural enterprises.

4.0 Conclusion

Given the economic burden associated with diseases and death resulting from parasitic diseases, it becomes important to have a well developed scheme to attributing relative importance to diseases and resource allocation therefore.

Physical, biological, sociological and psychological variables are significant determinants of disease distribution and patterns. Epidemiology incorporates to a large extent mathematical and geographical tools in solving parasitic disease related public health issues.

4.0 Summary

5.0 Summary

Epidemiological tools help in explaining parasitic disease problems by incorporating geographical, temporal and mathematical aspects.

6.0 Tutor Marked Assignment (TMA)

a. Justify the use of DALYs in parasitic disease management programs

b. State the relative importance of different parasitic diseases on the basis of their DALYs estimate.

7.0 References/Further reading

Otubanjo, O.A. (2008) Elements of Parasitology Second Edition. Panaf Publishing Inc. Abuja 196pp.

Module 1

Unit 4: Types of animal associations

1.0 Introduction

2.0. Objective

3.0. Main content

3.1 Homospecific/intraspecific/ homogenetic and

3.2 Heterospecific/interspecific/heterogametic

3.3 Loose associations
3.4 Temporary associations
3.5 Intimate associations

4.0 Conclusion

5.0 Summary

6.0 Tutor-Marked Assignment

7.0 References/Further reading

Module 1

Unit 4: Types of animal associations

Content

1.0 Introduction

Organisms live within various habitats ranging from air, water and soil; interacting with each other in the environment. These associations are characterized by diverse benefits: provision of food, transport, protection, etc.

Within the environment, living organisms exhibit diverse forms of associations which may be broadly divided to two categories namely:

- Homospecific/intraspecific/ homogenetic and
- Heterospecific/interspecific/heterogametic

2.0. Objective

Proper understanding of animal association, with examples of host-parasite interactions and the challenges therein. Ability to carry out basic sample preparation for microscopy and common parasite identification.

3.0. Main Content

3.1 Homospecific/intraspecific/ homogenetic

Thisdeals with relationships between organisms/members of the same species. E.g associations such as a flock of sheep, a school of fish, herds of cattle, colonies of coelenterates, filaments of algae, colonies of social insects (such as bees, termites and ants) etc. Thses associations are based on cooperative behavious within the groups. However this association falls outside the scope of parasitism.

3.2 Heterospecific/interspecific/heterogametic

This occurs between organism of different species, resulting from diverse biological links in morphology, ecology, physiology and biochemistry.

A spectrum of heterospecific associations may overlap, consisting of predation, phoresis, commensalism and parasitism.

Predation is non-specific and usually results in the death or injury of one of the interacting organisms. The degree of predation may be absolute, partial or temporary or insignificant. It forms the basis of interspecific associations among living things. Heterospecific relationships are

collectively called symbiosis. Animals may exhibit different types of symbiotic relationships which may be obligate or facultative. The three basic types of heterospecific relationships are:

- **Loose associations**
- **Temporary associations**
- **Intimate associations**

3.3 Loose Associations

This form of association is casual because they retain their physiological independence and are just ecologically linked. Loose associations provide biological advantages to those organisms in the association over those that are not in association. Significantly, it is usually one sided benefit. They include:

Phoresis

Commensalism

Phoresis (trnansport commencerlism) is a form of loose association in which an organism provides shelter, support or transport for the other organism,usually a sedentary animal of a different species. The passenger can survive without its usually motile substractum or attachment surface. There is no conflict of interest in this association. Examples are barnacles on limpet mollusks, dung beetle, *Aphodius fimentarius* carying dauver-lavae of *Pledora coactatata* (a free-living nematode which feeds on bacteria) etc.

Commensalism (Co= together, Mensa= table) is an association between two organisms in which one benefits, but the host is not hurt nor injured. It usually occurs between species that are either vulnerable to predation, danger or with an inefficient means of locomotion, feeding or edfence. It is the most indefinite and least obligatory inter-specific relatuionship. The host neither benefits nor looses in the relationship.

There are three types of commensalism

a. Cleaning: in which one organism cleans the other by feeding on the parasite of the host organism. E.g *Bulbus ibis* (cattle egret) feeds on ectoparasites on the skin of cattle, *Naucrates doctor* (pilot fish) feeds on the ectoparsites of shark.
b. Protection/camouflage.E.g the anemone hermit crab, *Dardanus pedunculatus* attaches several anemones to its shell, for camouflage and as a deterrent to possible predators.
c. Synoecious (syn= together, oikos= house): which involves animal living together in the shell/burrow of another animal. E.g *Mytilus edulis* (mussel0 harbours the pea crab (*Pinnotheras pisum*) within its mantle cavity.

3.4 Temporary associations

This form of association is typified by the predator- prey relationships in which one organism uses the other as a source of food. The predator usually kills the prey or eats part of it (as in

plants). E.g leeches feeding on blood of aquatic animals and some blood sucking insects such as lice and ticks.

3.5 Intimate associations

There are two basic forms of intimate associations. They are:

- Mutualism
  This is a non-competitive, physiologically interdependent association between organisms of two different species. It is considered as the most advanced form of symbiosis because it involves reciprocal benefits. They always live together and mutualism is recognized as a special case of parasitism, in which metabolic by-products of the associates are of valuae to the partners. E.g Trichonympha campanula (intestinal flagellates) feeds on the wood chips in the gut of termites and wood roaches. They by-products of cellulose digestion and cellulose of the flagellated protozoan are useful to the inscet. The sexual reproduction of the protozoa is stimulated and regulated by the insect moulting hormone, ecdysome. The anaerobic environment of the inscet's gut is integral to the survival of the flagellate. The two organisms depend on each other for survival. Physiological dependence is an essential component of mutualistic relationships.

3.0 Conclusion

Parasite association with the host confers them so much advantages for survival, hence the ultimate aim of parasitism unlike predation is not the mortality of the host, rather a parasite requires its host to survive to ensure continued supply of food materials.

4.0 Summary

- Parsite-host relationship is a form of symbiosis
- The parsite benefits at the expense of the host
- The relationship may be loose, temporary on intimate

6.0 Tutor-marked Assignment

State the different kinds of parasite-host associations and the describe the parasite adaptations for each

7.0 References/Further reading

Otubanjo, O.A. (2008) Elements of Parasitology Second Edition. Panaf Publishing Inc. Abuja 196pp.

Module 1

Unit 5: The concept of Parasitism

Module 1

Unit 5: The concept of Parasitism

Content

1.0 Introduction

Parasitism (para= beside; sitos=food).
Parasitism is at the root of several diseases and deformities in many vertebrates. The degree of effect depends on the type of parasite, its mode of action and of course the host physiological state.

2.0 **Objective**
At the end of the class, student must be familiar with the types of parasites and hosts and the basis for parasite and host categorization.

3.0 Main content

3.1 Parasitism

This is a physiological association in which one organism (the parasite) benefits while the host looses. It is one-sided and it is a social and ecological relationship between two different organisms, one being injured in the association.

Parasitology therefore is defined as an aspect of symbiology which deals with the study of parasites. It is a medical and ecological science that encompasses the study of parasite and parasitic diseases.

A parasite is defined as an organism which has a detrimental effect on the intrinsic growth rate of its host population

Parasitism is also defined as an association, generally continuous, between two different organisms, one of which lives at the expense of the other.

3.2 Types of parasites

Parasites may be plants, animals, bacteria or viruses and they occur in every phylyum in the Kingdom animalia, ranging from protozoans to chordates. They are categorized based on different criteria.

3.2.1 Site of residence or habitat:

Ectoparasites

Endoparasites

3. 2.2 Duration or degree of dependence

Temporary parasites

Permanent parasites

3.2.3 Nature of host

Hyper-parasites (parasites of parasites)

Cleptoparasites (organisms that steal food reserves of its host to feed its young)

3. 2.4 Other types of parasites includes

Wandering /Errant/Aberrant parasites

Occasional/Accidental parasites

Obligatory/Obligate parasites

Facultative parasites

Microparasites

Macroparasites

Pseudoparasites

Coprozoic or spurious parasite

4.0 Conclusion

Parsites vary in taxa, mode of action , host selection and behavior and thse factors together determines the pthogenicity and hence the importance attributed to a given parasite.

5.0 Summary

6.0 Tutor Marked Assignment (TMA)

a. what is a parasite?

b. state the criteria for categorizing parasites.

5.0 References/Further reading

Otubanjo, O.A. (2008) Elements of Parasitology Second Edition. Panaf Publishing Inc. Abuja 196pp.

MODULE 2:

Unit 1: Types of Parasite Host

Module 2:

Unit 1: Types of Parasite Host

Content

1.0 Introduction

The Host is a key component of parasitic relationship and some parasite may require more than one host to complete their life cycle. Others simply have alternative host, infecting a broad range of animals.

2.0 Objective

At the end of the class, student must be familiar with the types hosts and the basis for parasite and host categorization.

3.0 Main content

3.1 Types of hosts

A host is the non-parasitic member in a parasitic association. It habours the parasites and thus provides itself as the environment of the parasite, albeit involuntarily. Biotic and abiotic factors of the host influence the survival, distribution, prevalence, intensity, etc. of the parasite. Abiotic factors in the host include:

- pH
- O_2
- CO_2

There are different types of hosts, depending on a number of criteria. They include:

Definitive or Primary host

Intermediate or secondary host

Reservoir host

Paratenic/transport/carrier host

Ecological host

Vector

Dead end host

Hosts, parasite stage and host necessity

Type of host	**Stage of parasite in the host**	**Necessity of the host**
Definitive	Adult	Essential
Intermediate	Juvenile	Essential
Paratenic	Juvenile	Ecologically necessary
Vector	Juvenile	Essential
Reservoir	Adult	Not Essential

3.2 Host-parasite Interactions/Relationships

Generally, parasites may locate their host directly or indirectly and then establish a relationship that is determined by ecological, physiological, geographical and evolutionary factors. The selective and dynamic phenomenon of parasite adaptation to certain hosts is known as host specificity.

Specificity results from a number of convergent phenomena, starting with habitats, microhabitat and feeding styles of the free-living progenators. This influences the types of interaction parasites have with the host and through this specificity results.

4.0 Conclusion

Parasite-host interaction is dynamic and relies and is intimately tied to their life cycle selection.

5.0 Summary

The different categories of parsite hosts are definitive, intermediate, paratenic, vector and reservoir.

Depending on the host different life cycle stages of the parasite may be found and some hosts may not be essential in the life cycle

6.0 Tutor Marked Assignment (TMA)

a. What is a host?

b. What are the host abiotic factors which form the parasite ecosystem ?

7.0 Refrences/further readings

Yoloye, L.V. (1984) *Invertebrate Zoology*. Ilorin University Press, Ilorin. 318pp.

Otubanjo, O.A. (2008*) Elements of Parasitology* Second Edition. Panaf Publishing Inc. Abuja 196pp

Module 2

Unit 2: Host Selection and Host specificity

Module 2

Content

Unit 2: Host Selection and Host specificity

1.0 Introduction

Parasite-Host interaction is often specific, with a parasite living on a sigle host or on closely related host taxa. Their choice of host and host specificity depends on a number of factors ranging from structural, physiological to environmental.

2.0 Objective

At the end of the class, student must be familiar with the different factors which influence parasite host selection, specificity, adaptations and co-evolution with its host as well as immunological factors leading to host resistance and host protection.

3.0 Main content

3.1 Host Selection

Parasites may possess single or a wide range of hosts in their life cycle. They may be:

Monoxenous i.e if they possess a single host,

Oligoxenous i.e if they utilize a small range of host

Polyxenous, i.e if they use many suitable hosts.

Parasites with indirect life cycles are less host specific than those with direct life cycles. Thus there is less host specificity with increase in the number of intermediate host. Co-evolutionary factors are important in parasites that feed on host tissues or occur in extra intestinal sites. This is because the parasite must present the right cues/signals and respond appropriately to host defense system. The inability of a parasite to respond to such cues may act as a barrier on its host range.

3.2 Host specificity

The host range or host specificity of a parasite is the collection of hosts that an organism can utilize as a partner. In the case of human parasites, the host range influences the epidemiology of the parasitism or disease. Specificity in parasites is seldom absolute. It differs amongst various types of parasites and at different stages of the parasite life in the definitive and intermediate hosts. Majority of parasites however are restricted to just one or few closely related species.

Supra –specific condition occurs when groups of parsites are associated with natural groups of host.

Infra-specific conditions on the other hand occur when a single species of parasite is associated with a single host. Over 70% of described monogenetic trematodes are infra- specific.

Phylogenetic, physiological, ecological and human factors affect parasite specificity. Specificity is the effect of biological compatibilities between hosts and parasites. The range of host can be limited by lack of host stimuli, host immune response, innate resistance and simply the availability of essential nutrients to the parasite.

Localization of, establishment, growth and reproduction are factors which contribute to host specificity. Behavioral adaptations have also contributed tremendously to increase the chances of host location. Chemical cues emitted by hosts play vital roles in the infective stages locating or finding their hosts. Host selection is determined by morphological and physico-chemical factors.

4.0 Conclusion

The success of parasitism depends on the specificity of host parasite relationships. Ability to secure the appropriate host is key to parasite survival and hence it attracts a lot of energy investment, often requiring co-evolution with the host.

5.0 Summary

6.0 Tutor Marked Assignment (TMA)

a. What is host specificity?

b. list the criteria for parasite host selection

5.0 References/Further reading

Croll, N.A. (1973). Parasitism and other associations. Pitman medical, London, 98pp.

Otubanjo, O.A. (2008*) Elements of Parasitology* Second Edition. Panaf Publishing Inc. Abuja 196pp

Module 2

Unit 3: Parasite and Host Associations

Module 2

Unit 3: Parasite and Host Associations

Content

1.0 Introduction

Host specificity is in a state of constant flux and is a product of evolution. Host specificity, may be lost in the course of evolution, thus reflecting the dynamism of parasite host relationships.

2.0 Objective

At the end of the class, student must be familiar with the different factors which influence parasite host selection, specificity, adaptations and co-evolution with its host as well as immunological factors leading to host resistance and host protection.

3.0 Main content

3.1 Parasite adaptations and evolution

Host–parasite co-evolution is a special case of co-evolution, which is defined as the reciprocal adaptive genetic change of two antagonists (e.g. different species or genes) through reciprocal selective pressures. In the particular case of host–parasite co-evolution the antagonists are different species of host and parasite**.** Hosts and parasites exert reciprocal selective pressures on each other, which may lead to rapid reciprocal adaptation. For organisms with short generation times host–parasite co-evolution can be observed in comparatively small time periods, making it possible to study evolutionary change in real-time under both field and laboratory conditions**.**

Specificity patterns are shaped during the course of parasite evolution. Phylogenetic specificity is determined by ecological or physiological factors or a combination of both.

The evolutionary basis of host specificity is supported by the fact that primitive hosts habour primitive parasites. Hosts of monophyletic (single) are parasitized by an exclusive group of parasites. Parasites that evolved with their hosts are known as heirlooms while those that are picked up through ecological links or contact are known as souvenirs. E.g adults of family Taenidae parasitize only mammalian hosts. Elasmobranchs are exclusive hosts of the tapeworms of the order Tetraphyllida and tetrarhyncha.

3.2 Host resistance and Host protection

Host resistance

Free-living organisms struggle predominantly with abiotic factors within the environment for their survival. Biotic and abiotic factors of parasite habitats affect the establishment, maintenance and survival in the host.

They experience varied destructive factors in their host and their ability to establish, survive and maintain their presence in their host is always under threat. They are affected by host immunity which constantly produce antibody against parasite.

Host resistance refers to the unsuitability of a host. This is however never absolute. It may result from the presence of some physical or chemical barriers that prevents parasite from establishing in a host. A number of host characteristics such as physiology, behavior and structure influence host-parasite interactions, thereby influencing host resistance. Host natural resistance can also arise through geographical distribution, behavioural characteristics of the host or nutritional habits as the host may not come in contact with the infective stages.

Natural resistance encompasses a physiological incompatibility between parasite and host, preventing parasite invasion, establishment and survival, without the intervention of immunological- based protective responses. It is influenced by factors such as host's genetic composition, age, nutritional status and gender.

Host protection

Organisms are able to distinguish between self and non-self using immune response. While many parasites have evolved successful means of evading host immune response, the ability of the host to control the parasite is not absolute. Various host exhibit different degrees of susceptibility or resistance for parasitic agents or specific infections.

Hosts are protected from infection by:

4 Non-specific resistance and
5 Specific immunity or protection

Non-specific resistance is also known as innate or natural immunity. It includes mechanisms which the host is genetically endowed with at birth and thereby protected from certain infections.

4.0 Conclusion

Parasitism requires high energy investment on the part of the parasite to evade host immunological responses.

5.0 Summary

- Parasites have to adapt to host conditions to survive.
- Hosts have innate mechanism to fight against parsites.
- The success of parasitism depends on the parasites ability to evade host immune response.

6.0 Tutor Marked Assignment (TMA)

a. List the factors that affect host-parasite co-evolution

b. write short notes on host resistance and host protection

6.0 References/Further reading

Otubanjo, O.A. (2008). Elements of Parasitology Second Edition. Panaf Publishing Inc. Abuja 196pp.

Module 2

Unit 4: Protozoa

Module 2

Unit 4: Protozoa

Content

1.0 Introduction

Protozoans are a polyphyletic group of unicellular animals whose mode of classification is primarily based on their locomotory organelle. All protozoan phyla contains parasitic members. The mode of transmission, location within host and pathogenicity varies widely. Protozoans are the most common parasites of vertebrates.

2.0 Objective

Students would at the end of this lesson, be conversant with the different types of protozoan parasites, their taxonomy, characteristics, life cycle, pathenogenicity, epidemiology and management . Basic laboratory parasite assessment skill using light microscopy.

3.0 Main content

3.1 **Taxonomy**

The basic taxonomic character for this group is the absence/presence and type of motile organelles

Sarcodina e.g. *Entamoeba*
Matsigophora e.g. *Trypanosoma, Trichomonas, Leishmania, Opalina, Giardia*
Ciliophorans e.g. *Balantidium*
Apicomplexa e.g. *Toxoplasma, Plasmodium, and Eimeria*.

3.2 Biology (Characteristic Features)

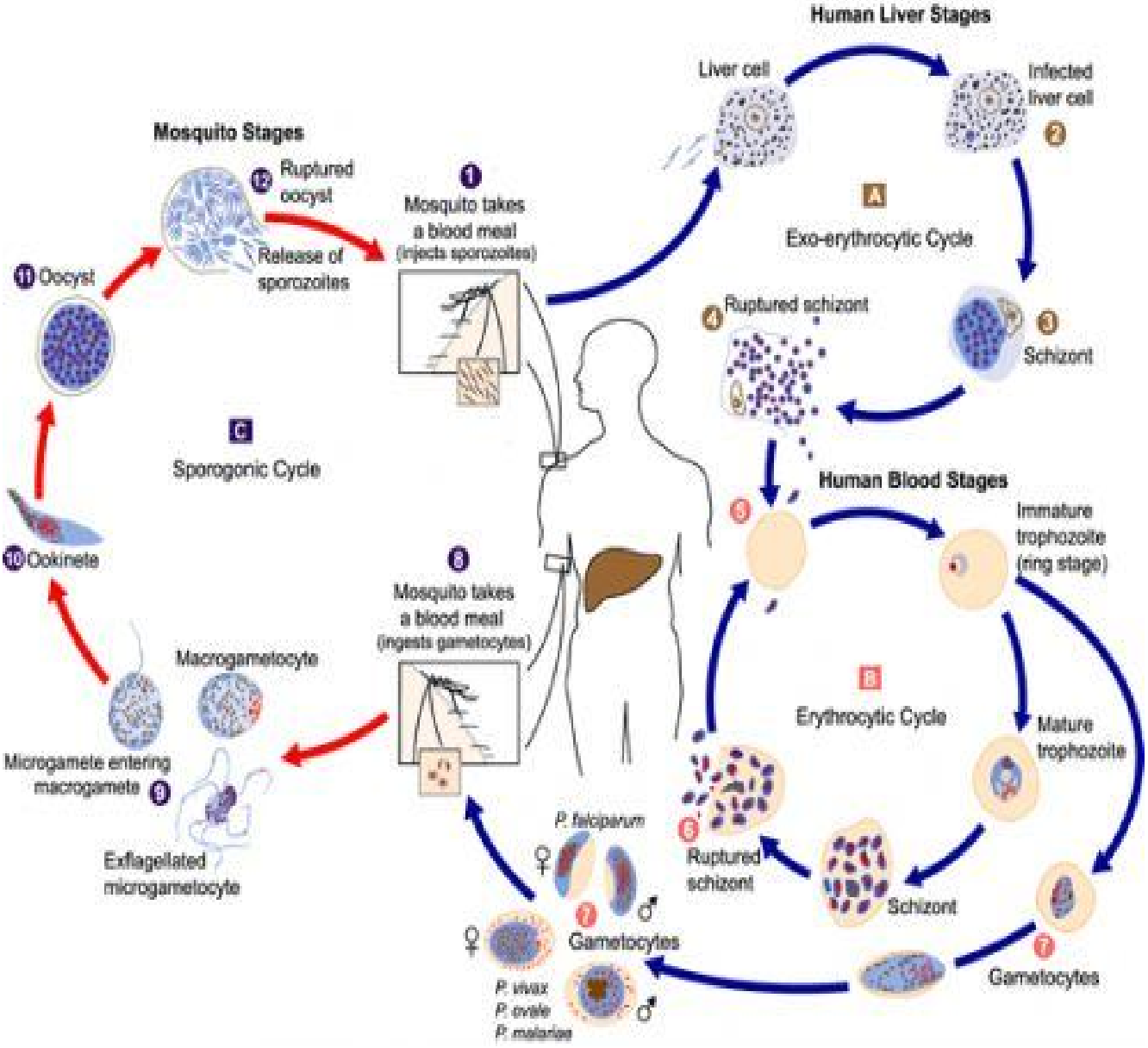
Protozoans are generally unicellular, microscopic eukaryotic organisms. They are the first animals with membrane-bound nucleus, as well as heterotrophism. A considerable number of these organisms have motile organelles; while majority have at least one stage of their life cycle being motile.

3.3 Parasitic Protozoology (Protozoans of parasitic importance)

These include *Entamoeba spp (E. histolytica, E. coli, E. gingivalis), Opalina ranarum, Trypanosoma (T. brucei brucei, T. brucei rhodesiense, T. brucei gambiense, and T. cruzi), Trichomonas (T. vaginalis), Leishmania (L. donovani, L. aethiopica), Giardia lamblia, Balantidium coli, Toxoplasma gondii, Plasmodium (P. falciparum, malariae, ovale, and vivax),* and *Eimeria.*

3.4 **Life Cycle**

This is generally asexual, involving binary fission, multiple fissions (schizogony, Merogony, Sporogony, Polyembryony), budding, and sexual (syngamy, autogamy, and conjugation). Many of these organisms have direct life cycle (wherein parasites undergo complete development within the host), while some others have part of their life cycle completed outside the host; this could be a substratum, intermediate host and/or vectors.



Life cycle of Protozoan parasite (Plasmodium sp.) which causes malaria (Centre For Disease Control, USA).

3.5 *Pathogenicity*

Many of these parasites are found in nutrient-rich sites such as the GIT (especially the small intestine) liver, blood plasma, blood cells, and other tissues Epidemiology, Control and Management.

4.0 Conclusion

Protozoans are a polyphletic group of unicellular animals. There are parasitic protozoan species in all the taxonomic classes. They are ubiquitous and are among the most common and most deadly parasites.

5.0 Summary

7.0 Tutor- Marked Assignment

a. Draw, lable and write short notes on 5 protozoan parasite

b.Describe the Life cycle of the malaria parasite (*Plasmodium* spp)

7.0 References/Further reading

Yoloye, L.V. (1984) Invertebrate Zoology. Ilorin University Press, Ilorin. 318pp.

Otubanjo, O.A. (2008) Elements of Parasitology Second Edition. Panaf Publishing Inc. Abuja 196pp

Ukoli, F.M.A. (1990). Introduction to parasitology in Tropical Africa. Texflow Limited, Ibadan. 462pp.

Module 2

Unit 5: Trematodes

Module 2

Unit 5: Trematodes

Content

1.0 Introduction

Trematodes constitute a group of parasitic flat worms commonly referred to as flukes. They may be Monogenetic or digenetic-The latter are characterized by two hosts, a definitive host and an intermediate host usually a mollusc.

2.0 Objective

Students would at the end of this lesson, be conversant with the different types of trematodes of parasitic importance, their taxonomy, characteristics, life cycle, pathenogenicity, epidemiology and management. Preparation

3.0 Main content

3.1 General Taxonomy of Helminthes

Flatworms is broadly divided into two classes; Monogeneans and digeneans. The monogenetic trematodes are so called due to the completion and dependence on a single host, and are common with aquatic vertebrates (fishes). Examples are *Dactylogyrus and Gyrodactylus*. Digenetic trematodes compulsorily complete their life cycle between two different host species. The most common ones include *Fasciola* (*F. hepatica and F. gigantica*), *Schistosoma (S. haematobium, S. mansoni, S. japonicum, S. intercalatum, S. mekongi), Paragonimus westermani, and Clonorchis sinensis.*

3.2 Biology (Characteristic Features)

These are bilaterally symmetrical triploblastic organisms, pronounced cephalization, and the onset of specific physiologic organs. However, parasitic flatworms are devoid of respiratory, circulatory, and digestive systems absent. Trematodes are generally flat, elongate and non-segmented worms.

3.3 Life Cycle:

Parasitic flatworms are basically hermaphroditic (except *Schistosoma spp*)

3.4 Pathogenicity

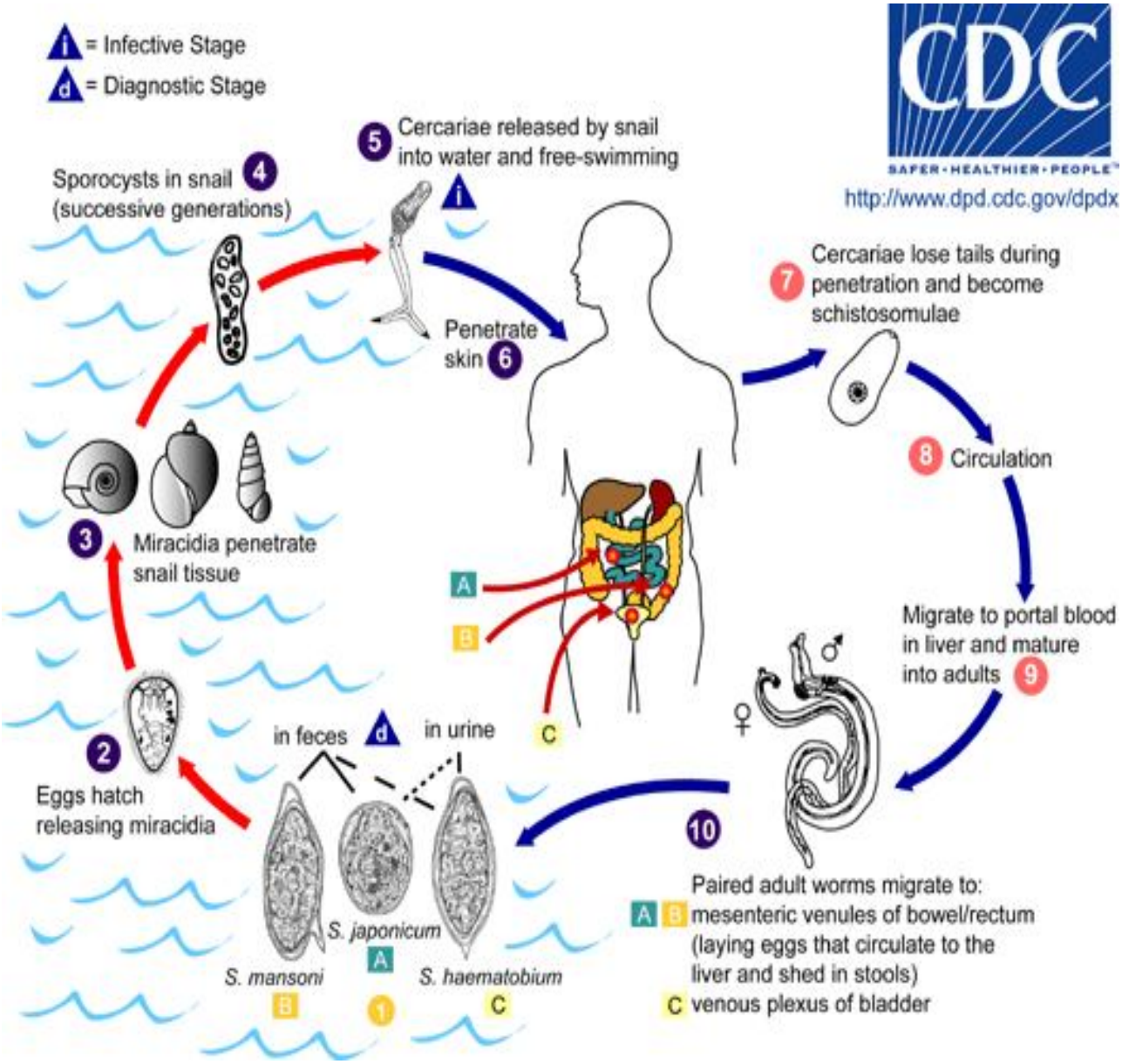
These parasites invade organs such as musculature, lungs, renal and intestinal blood vessels, as well as liver of mammals.

3.5 Epidemiology and management

Trematode infection is common in the tropic particularly in places whre there is a preponderance of their snail intermediate host.

4.0 Conclusion

Trematodes constitute and important class of parasites with both human an veterinary burden.



Life Cycle of the Trematode (*Schsitosoma* sp)

5.0 Summary

- Trematodes are often refered to as flukes
- Common flukes includes blood fluke (*Schistosoma* sp.), liver fluke (*Fasciola* sp.), lung fluke (*Paragonimus* sp.)
- They are digenetic, requiring an intermediate host, mostly mollusk for their transmission.

6.0Tutor Marked Assignment

a. List the common Digenetic trematodes, their coomon and scientific name as well astheir hosts.
b. Write short note on schistosomiasis

7.0 References/Further reading

Yoloye, L.V. (1984) *Invertebrate Zoology*. Ilorin University Press, Ilorin. 318pp.

Otubanjo, O.A. (2008*) Elements of Parasitology* Second Edition. Panaf Publishing Inc. Abuja 196pp

Hickman *et al.* (2008). Integrated principles of Zoology. 14th Edition, Mc-Graw Hill. 910pp

MODULE 3:

Unit 1: Cestodes

Mosdule 3:

Unit 1: Cestodes

1.0 Introduction:

Cestodes are flatworms, commonly referred to as tapeworms becuae of their long tape-like appearance, with some growing up to several meters long. They are endoparasites of vertebrates such as fishes, swine, cattle, cats, man and a host of others.

2.0. Objective

At the end of the class, student must be familiar with the different species of cestodes, their host, mode of transmission and management practices.

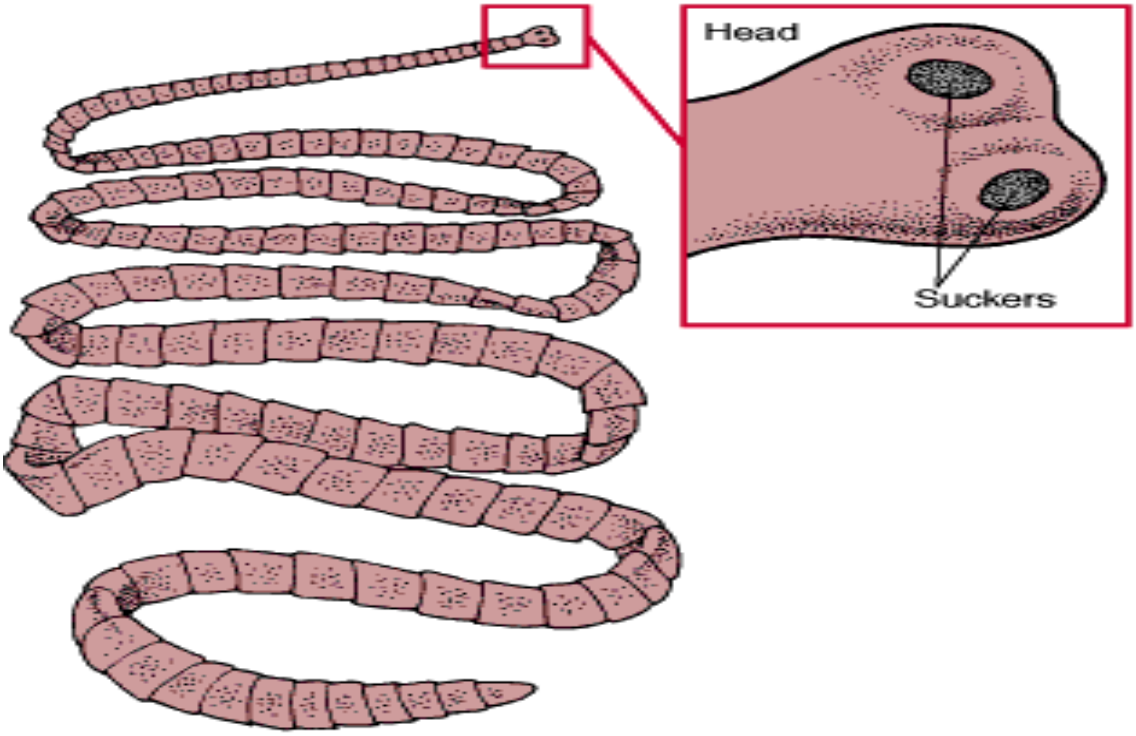
3.0. Main content

3.1 **Taxonomy**:

Members are of the Class Cestoda, Sub-Orders Eucestoda and Cestodaria. Examples include *Taenia* (*T. solium, T. saginata*), *Diphyllobothrium latum, Dipylidium canimum, Hymenolepis nana, and Echinococcus granulosus*

3.2 Biology (Characteristic Features)

These are flat, elongated and segmented worms. These segments progressively increase in size and complexity away from the cephalic regions (Strobilization). Immature proglottids are closer to the head, mature ones intermediate, while gravid ones are farthest from the head. Head region is provided with adhesive suckers and hooks for 3attachment to host for phoretic and nutritional purposes.



A typical Tapeworm (*Taenia* sp.)
(http://www.medicalook.com/diseases_images/tapeworm2.gif)

3.3 Life Cycle

Members are all hermaphrodites, and life cycle involves self-fertilization, with the production of encysted eggs stored in the musculature of intermediate hosts.

3.4 Pathogenicity

Involves the disruption of skeletal musculature in respective intermediate and definitive hosts, with pronounced adverse in the latter.

3.5 Epidemiology and management

The infection is common in areas with high dependence on animal protein (beef, pork, fish), as well as intermittent contact with domestic and wild canids, especially in unhygienic conditions
Management involves good sanitary conditions of living and cooking, as well as minimal contacts with unhealthy canids.

4.0 Conclusion

They are efficiently adapted endoparasites, taking advantage of their well developed scolex (head) which is armed with suckers and hooks for attachment. They also rely on their highly efficient integument armed with microvilli structures to absorb digested food within the gut.

5.0 Summary

- Cestodes are endoparasites of vertebrates
- Mode of transmission to human is through poorly cooked beef, pork or fish.
- In animals transmission is by faeco-oral means through consumption of cysts (eggs covered in protective casing).

6.0 Tutor-marked Assignment

Using annotated diagramme describe the life cycle of a named cestode.

7.0 References/Further reading

Yoloye, L.V. (1984) *Invertebrate Zoology*. Ilorin University Press, Ilorin. 318pp.

Hickman *et al*. (2008). Integrated principles of Zoology. 14th Edition, Mc-Graw Hill. 910pp.

Module 3

Unit 2: Nematode

Module 3

Unit 2: Nematode

Content

1.0 Introduction

Nematodes are round, cylindrical worms with pointed ends. they are ubiquitous in distribution, and are found parasitizing humans and wild life in different climes.

2.0. Objective

At the end of the class, student must be familiar with the different nematode classes, common nematode parasitic diseases, medical importance and chemotherapy.

3.0. Main content

3.1 Taxonomy:

There are basically two Classes namely Phasmidea and Aphasmidea, with the taxonomic character being the absence/presence of phasmids.

3.2 Biology (Characteristic Features)

Nematodes are round, elongate, cylindrical unsegmented worms. Integument is non-cellular, and musculature is of the longitudinal type. Nematodes are dioecious, with distinct sexually dimorphism. They are also characterized sensory papillae at both ends of the body (amphids). Examples include *Ascaris, Dracunculus, Loa, Oncchocerca, Wuchereria, Brugia, Ancylostoma, Necator, Enterobius, trichinella, and Trichuris.*

A Soil transmitted nematode

3.3 Life Cycle

Sexes are separate, with copulation and fertilization occurring in the definitive hosts. Some have direct life cycle with re-infection enhanced by poor sanitary conditions, while others have indirect life cycle involving one or more intermediate hosts or vectors.

3.4 Pathogenicity

Involves impairment of tissues such as the skeletal musculature, subcutaneous tissues, GIT, respiratory system, as well as the eyes. Juvenile stages known as filarial worms of some members of this parasite groups are the cause of a number of disfiguring diseases which are prevalent in the tropics

These includes:

Onchocerciasis?River blindness – cause by *Onchocerca volvulus*

Guinea worm infection- caused by *Drancumculus medinensis*

Filaris of all kinds

a. Loasis (Calabar swelling)- caused by *Loa loa*
b. Elephantiasis (bancroftian filariasis- caused by *Wuchereria bancrofti*

Hook worm- caused by *Necator americana* and *Ancyclostoma deuodenale*

3.5 Epidemiology and management

Involves vulnerable groups with high exposure to insanitary conditions (lack of pipe-borne water and decent toilet facilities). They are ubiquitous i.e widespread but very common in the tropics where temperature is optimal for their vectors. Agood number of them are transmitted by arthropod vectors.

Maqngement practices for nematode control includes; good sanitary conditions, chemoprophylaxis and chemotherapy (Ivermectin, Mebendezole etc).

4.0 Conclusion

Nematodes constitute one of the largest collections of parasitic species infecting vertebrate hosts. They are often associated with poor sanitation which is prevalent in poor underdeveloped nations of the world.

5.0 Summary

Nematodes are called round worms because of their cylindrical appearance.

They have a global distribution and they comprise one of the largest parasite group.

They cause a number of debilitating and deforming diseases such as River blindness etc.

6.0 Tutor Marked Assignment (TMA)

a.Make a list of different nematode parasites, their vectors and the disease they cause in humans.

b.Draw the structure of the common round worm *Ascaris lumbricoides*

7.0 References/Further reading

Hickman *et al.* (2008). Integrated principles of Zoology. 14th Edition, Mc-Graw Hill. 910pp

Yoloye, L.V. (1984) *Invertebrate Zoology*. Ilorin University Press, Ilorin. 318pp.

Module 3

Unit 3: Acanthocephalans

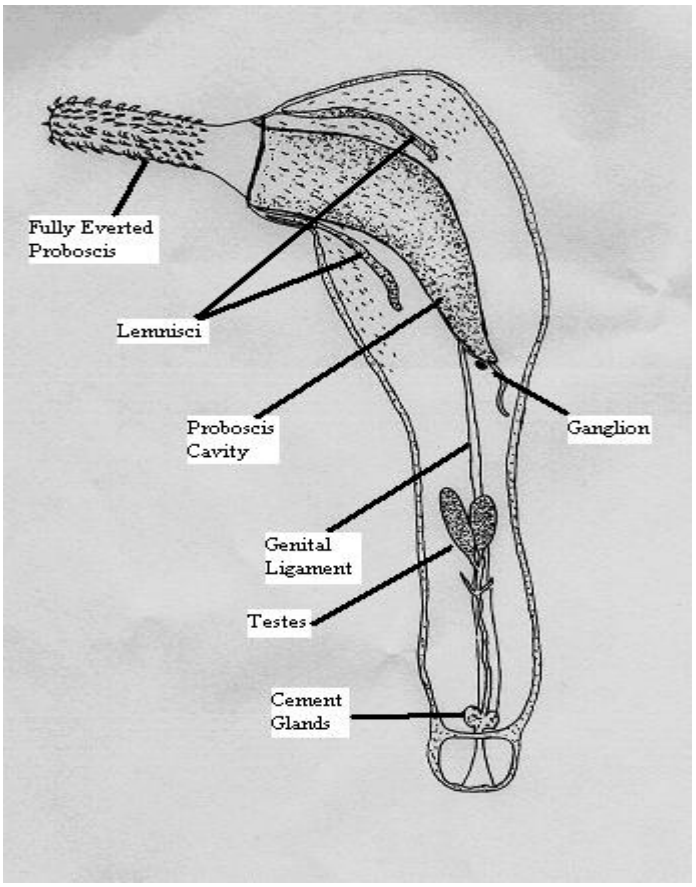
Hickman *et al.* (2008). Integrated principles of Zoology. 14th Edition, Mc-Graw Hill. 910pp.

Module 3

Unit 3: Acanthocephalans

1.0 Introduction

Acanthocephala (Greek ἄκανθος, *akanthos*, thorn + κεφαλή, *kephale*, head) is a phylum of parasitic worms known asacanthocephales, thorny-headed worms, or spiny-headed worms, characterized by the presence of an evertableproboscis, armed with spines, which it uses to pierce and hold the gut wall of its host. Acanthocephalans typically havecomplex life cycles, involving a number of hosts, including invertebrates, fishes, amphibians, birds, and mammals.



Structure of an Acanthocephalan

2.0. Objective

At the end of the class, student must be familiar with the parasitic acanthocephalans, their pathogenicity and epidemiology.

3.0. Main content

3.1 Taxonomy

About 1150species have been described.The most common acanthocephalan include *Macracanthorhyncus sp*, the parasite of pigs.

3.2 Biology (Characteristic Features)

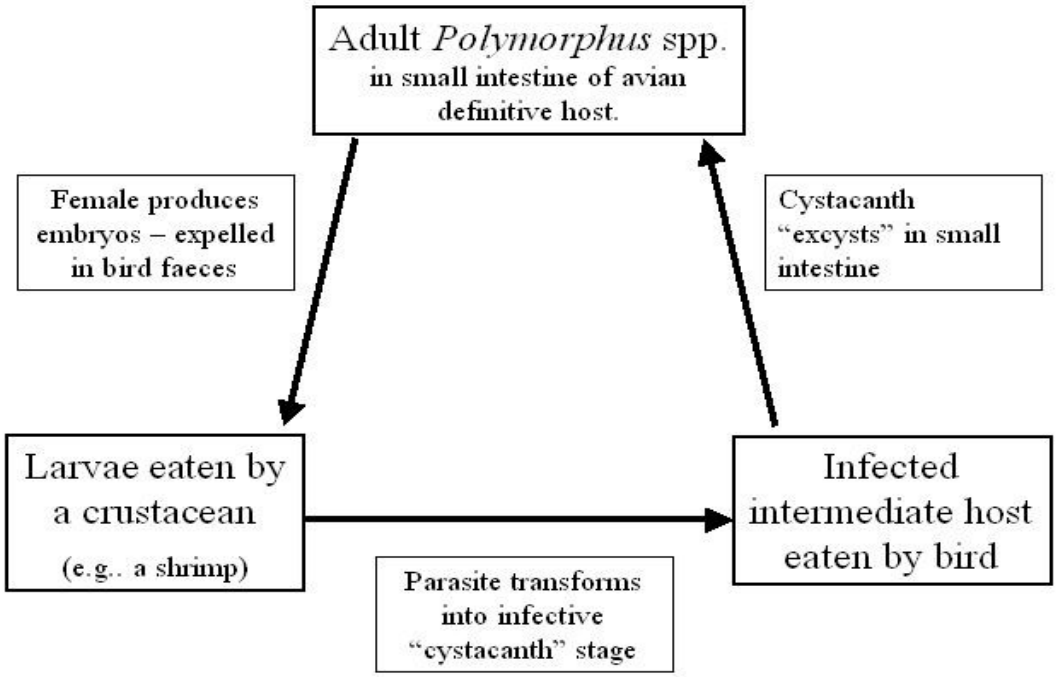
Acanthocephalans are highly adapted to a parasitic mode of life, and have lost many organs and structures through evolutionary processes. The size of the animals varies greatly, from forms a few millimetres in length to *Gigantorhynchus gigas*, which measures from 10 to 65 centimetres (3.9 to 26 in). The body surface of the acanthocephala is peculiar. Externally, the skin has a thin cuticle covering the epidermis, which consists of a syncytium with no cell walls. The syncytium is traversed by a series of branching tubules containing fluid and is controlled by a few wandering, amoeboid nuclei. Inside the syncytium is an irregular layer of circular muscle fibres, and within this again some rather scattered longitudinal fibres; there is no endothelium. In their micro-structure the muscular fibres resemble those of nematodes.

Members are characterized by a cylindrical invaginated proboscis bearing rows of spines, hence the common name 'spiny-headed worms'. These spines are used for attachment to hosts. Members are endoparasites of vertebrates, especially fish, birds and mammals.

3.3 Life Cycle

Sexes are separate in acanthocephalans, with immature stages developing in invertebrates such as crustaceans and/or insects. Fully developed embryos are retained within the shell, egested with host faeces and remain unshelled until uptake by intermediate host. Acanthocephalans have complex life cycles, involving a number of hosts, for both developmental and resting stages. Complete life cycles have been worked out for only 25 species.

The lifecycle of *Polymorphus* spp., acanthocephalan parasites of birds.



3.4 Pathogenicity

They are generally intestinal parasites, especially the duodenal arm of the small intestine. The nutritional requirement of these organisms, as well as release of metabolic wastes into host system severely impairs host, manifesting in clinical symptoms such as emaciation, anaemia and stunted growth and development.

3.5 Epidemiology and Management

They are cosmopolitan in distribution. Management procedure includes general hygienic condition, proper cooking of animal protein, chemotherapy.

4.0 Conclusion

Acanthocephalans are a bizarre and poorly studied parasitic group which are important causes of very disturbing gastric and intestinal conditions. Prevalence is common among poor and aqualor dwelling coastal communities.

5.0 Summary

6.0 Tutor Marked Assignment (TMA)

a. Design a checklist of acnthocephalans of medical importance

b. Describe a typical acnthocephalan life cycle.

7.0 References/Further reading

Hickman *et al.* (2008). Integrated principles of Zoology. 14th Edition, Mc-Graw Hill. 910pp.

Module 3

Unit 4: Leeches

Module 3

Unit 4: Leeches

Content

1.0 **Introduction**

Lechhes, coomonly called blood leeches are haematophagus, feeding on vertebrate host. They are aquatic and considered to be temporary ecto-parasites, separating from their hosts after blood meal. Leeches are segmented worms that belong to the phylum Annelida and comprise the subclass Hirudinea.[1] Like otheroligochaetes such as earthworms, leeches share a clitellum and are hermaphrodites. Leeches, such as the *Hirudo medicinalis*, have been historically used in medicine to remove blood from patients.

2.0. Objective

At the end of the class, student must be familiar with the Hirudo species, their habitat and mode of parasitism.

3.0 Main Content

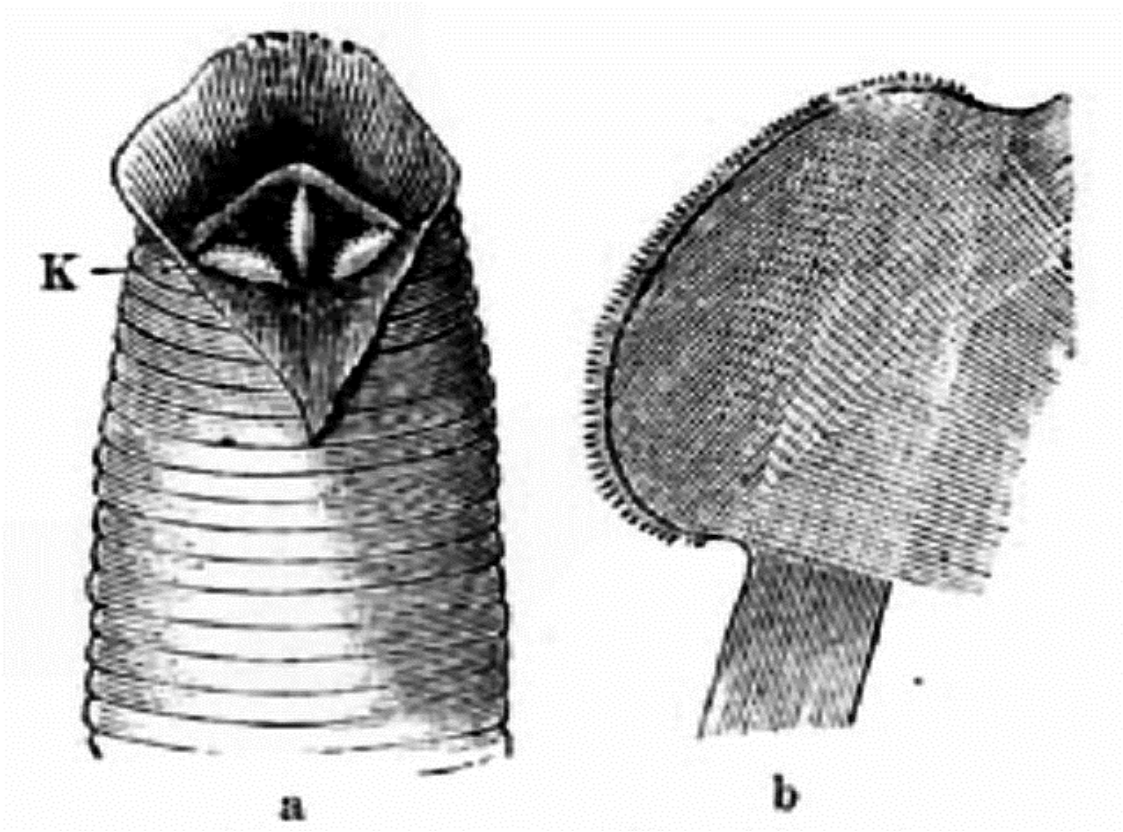
3.1 Taxonomy

Leeches belong to the phylum Annelida and Class Hirudinea. A common example is ***Hirudo sp***

3.2 Biology (Characteristic Features)

Leeches are dorso-ventrally flattened and segmented worms, with anterior and posterior suckers present for attachment to host and movement. Leeches are ectoparasitic, hence all organ systems are well developed. Their suckers are for attachement to their host during blood meal. Leeches are able to display a variety of behaviors that allow them to explore their environments and feed on their hosts. Exploratory behavior includes head movements and body waving

Most leeches do not feed on human blood, but instead prey on small invertebrates, which they eat whole. To feed on their hosts, leeches use their anterior suckers to connect to hosts for feeding, and also release an anesthetic to prevent the hosts from feeling them. Once attached, leeches use a combination of mucus and suction to stay attached and secrete an anticoagulant enzyme,hirudin, into the hosts' blood streams. Though certain species of leeches feed on blood, not all species can bite;



Dorsal and ventral view of the sucker of the leech, *H. medicinalis*

3.3 Life Cycle

Members are hermaphrodites, with exchange of gametes between two individuals, with eggs (in cocoons) buried in damp/moist or aquatic sites. Leeches reproduce by reciprocal fertilization, and sperm transfer occurs during copulation. Similar to the earthworms, leeches also use a clitellum to hold their eggs and secrete the cocoon.

3.4 Pathogenicity

Involves benign skin inflammation upon blood meal, as well enhance secondary infection via viral, bacterial and fungal agents.

3.5 Epidemiology and mangement

Leeches are found in fresh water bodies, particularly in slow moving streams, rivers, lakes and pond of the tropics, where residents have intermittent contact with water.

5.0 Conclusion

Leeches are a controversial parasitic group because most feed on small invertebrates by way of predation. Only a few feed on larger vertebrates by way of parasitism

5.0 Summary

- Leeches are belong to the invertebrate class Annelida
- Like otheroligochaetes such as earthworms, leeches share a clitellum and are hermaphrodites
- Only a few species live as ecto-parasites, the rest are predators.

6.0 Tutor Marked Assignment (TMA)

a. Leeches are a controversial group of parasites. Discuss.

7.0 References/Further reading

Hickman *et al.* (2008). Integrated principles of Zoology. 14th Edition, Mc-Graw Hill. 910pp

Module 3

Unit 5: Arthropods

Module 3

Unit 5: Arthropods

Contents

1.0 Introduction

Arthropods are winged invertebrates which are characterized by the possession of cuticular exo-skeleton. They vary widely in terms of their general body divisions, number of appendages, life cycle stages and habitat. They are the most successful animals on land and have a wide variety of niches, including those in which they act either as parasite vectors or parasites themselves (ecto-parasites).

2.0. Objective

At the end of the class, student must be the general arthropod taxonomy, the arthropod groups of parasitic importance (insect and acrina)

3.0. Main content

3.1 Taxonomy

Insects and Arachnids of parasitic importance. Quite a number of these organisms are of veterinary and medical importance, where they are considered vectors of diseases. Some of the important ones include ticks and mites, head and body lice, bedbugs, mosquitoes, tsetse flies, houseflies, deer flies, black flies, sand flies, biting midges.

3.2 Biology (Characteristic Features)

Members are characterized by the presence of jointed appendages, variable morphology, habitats and food types.

3.3 Life Cycle

This involves complete and/or incomplete metamorphosis. Arthropods with complete metamorphosis are usually more common as vectors of diseases, due to their varied diet and habitats, while those with incomplete metamorphosis are usually are more common as parasites.

3.4 Pathogenicity

Many of these parasitic arthropods induce allergic reactions, dermatitis, some feed on subcutaneous tissues, as well as direct/indirect transmission of disease agents.

3.5 Epidemiology and Management

These arthropods are associated with age-groups in unhygienic environments.
Management: good sanitary conditions, chemotherapy

4.0 Conclusion

Arthropds sre unique group of animals because some groups are vectors (conveyors) of parsite while others are themselves parasites (e.g Ticks and Mites).

5.0 Summary

- Arthropods are the most successful animals on land.
- They have diverse forms of existence, one of which is by parasitism.
- Arthropod ecto- parasites are common in the Order Acarina
- Arthropods may serve as vectors either mechanically or biologically.

6.0 Tutor-Marked Assignment

a. Design a catalogue of arthropod species specimen of medical importance, stating their host and whether they are vectors or ecto-parasites.

7.0 References/Further reading

Hickman *et al.* (2008). Integrated principles of Zoology. 14th Edition, Mc-Graw Hill. 910pp

Yoloye, L.V. (1984) *Invertebrate Zoology*. Ilorin University Press, Ilorin. 318pp.