

PARASITOLOGY

BIOL 460

GENERAL LECTURE TOPICS

(General Overview)

UNIT I

1. Introduction to Animal Parasitology
2. Definition of Terms
3. Parasitism as a mode of Life
 - ❖ Niches, habitats and environments of parasites
 - ❖ Reproductive potential of parasites
 - ❖ Modes of transmission of parasites

(General Overview)

UNIT. II

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- b) Helminthes
- c) Arthropods

(General Overview)

UNIT. III

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UNIT IV A

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- ❖ Ciliates
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(General Overview)

UNIT IV B

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(General Overview)

UNIT V

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b) Flukes (Trematodes)

❖ Liver

❖ Intestinal

❖ Lung

❖ Blood

General Overview

UNIT V (c)

c) Nematodes

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General Overview

UNIT VI

Parasitic Arthropods

- ❖ Insects
- ❖ Arachnids
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TERMINOLOGY IN PARASITOLOGY (DEFINITION OF TERMS)

- **Parasitology** is the science or **study of parasites** and the phenomenon of **parasitism**.
- **Parasitism** is a **symbiotic relationship** in which an organism (termed the **PARASITE**) or a population of the organism **depends on another organism** (termed the **HOST**, and which is usually of a different species) **and adversely affects** that on which it depends; the parasite cannot live without the host.

DEFINITION OF TERMS CONT'D

- **Symbiosis** is a term that describes the close association of two dissimilar organisms (each of which is called a symbiont) with various outcomes, depending on which there are the following types:
 - a) **Mutualism** – the association is beneficial to both symbionts
 - b) **Commensalism** – the association is beneficial to one and without effect on the other

INTRO CONT'D

- c) **Parasitism** – the association is beneficial to one but detrimental to the other
- d) **Amensalism** – the association is detrimental to one but without effect on the other
- e) **Synnecrosis** – the association is detrimental to both organisms

INTRO CONT'D

f) **Phoresis (or Transport Commensalism)** – the association is based on transportation only, i.e. one of the symbionts is dependent on the other to be transported from place to place; neither symbiont is physiologically dependent on the other; usually one partner (the one carried is smaller than the other (the carrier which is larger).

INTRO CONT'D

- ❖ A parasite is, thus, an organism living **in or on** another organism (host) of a different species from which it obtains food and protection; the relationship/dependence may or may not be harmful to the host.
- ❖ An organism may become parasitic only under certain conditions, in which case it is described as a **Facultative parasite** or it always lives a parasitic mode of life, in which case it described as an **Obligate parasite**.

INTRO CONT'D

- ❖ A parasite that lives on the surface or body of its host is called an **Ectoparasite**; one that lives in/within the body or organs of its host is called an **Endoparasite**.

- ❖ A parasite that lives in or attaches itself to the body of a species of host different from its normal one is referred to as an **Accidental** or **Incidental parasite.**
- ❖ e.g. nematodes that are normally parasitic in insects may live for a short time in the intestines of birds, or a rodent flea may bite a dog or human.

INTRO CONT'D

- ❖ Accidental parasites usually are unable to stay long on, or live long in the wrong host.
- ❖ However, some accidental parasites may be extremely pathogenic to their unfamiliar hosts.

INTRO CONT'D

- ❖ Some parasites live their entire adult lives within or on their hosts; such may be called **Permanent parasites**, whereas a **Temporary or Intermittent parasite** only feeds on the host and then leaves.
- ❖ A Temporary parasite may also be referred to as a **Micropredator** in that it may prey on several different hosts (or the same host at several discrete times).

Parasitism and Predation

- ❖ Parasitism and Predation are conceptually similar in that both the parasite and the predator live at the expense of the host or prey.
- ❖ The parasite, however, normally does not kill its host, it is, in size, relatively smaller than its host, has only one host (or one host at each stage in its life cycle) and is symbiotic.

Parasitism and Predation Cont'd

- ❖ On the other hand, the predator kills its prey, is larger in size relative to its prey, has numerous prey, and is not symbiotic.
- ❖ A parasite may sometimes, kill its host but this is not selectively advantageous since the life of the parasite is also, thereby, terminated

Parasitism and Predation Cont'd

- ❖ Thus, parasites have evolved adaptive mechanisms that enable them to get what they need from the host without killing it; indeed to produce few pathological conditions in the host is often a mark of a well-adapted parasite.
- ❖ Nevertheless, some parasites require pathological changes in host tissue in order to complete their life cycles.

Parasitism and Predation Cont'd

- ❖ The term **Parasitoid** is given to a large number of insects whose immature stages feed on their host's body, usually another arthropod, but finally kill the host during or after completion of the development of the parasitoid.
- ❖ They resemble predators in that they kill their hosts (prey) and parasites in that they require only one host.

Parasitism and Predation Cont'd

- ❖ A **Host** is an organism usually of a different species from that of the parasite in or on which the parasite depends for its survival or completion of its life cycle, or undergoes part of its developmental cycle.
- ❖ There are different categories of hosts, as follows:

Parasitism and Predation Cont'd

a) **Definitive Host** – the host in which a parasite reaches sexual maturity and reproduction. If no sexual reproduction occurs in the life of the parasite, e.g. a parasitic amoeba or a *Trypanosome*, the host believed to be most important is arbitrarily referred to as the Definitive host.

Parasitism and Predation Cont'd

b) **An Intermediate Host** – is one in which some development of the parasite occurs but in which the parasite does not reach maturity.

❖ In the case of the malaria parasite, *Plasmodium spp.* the mosquito is the Definitive host and humans or other vertebrates are the Intermediate hosts.

Parasitism and Predation Cont'd

- c) **A Paratenic Host** (also referred to as a **Transport Host**) – when a parasite in the body of a host does not undergo any development, but only continues to stay alive and remains infective to a definitive host, that host (not the definitive host) is referred to as a paratenic or transport host. Such hosts are often useful/necessary for the completion of the life-cycle of the parasite,
- ❖ since they may bridge an ecological gap between the intermediate and the definitive hosts.

Parasitism and Predation Cont'd

- d) **Reservoir Host** – an animal, including humans, that harbours an infection or a pathogen that can be transmitted to people is a reservoir host; the animal may even be a normal host of the parasite, it is a reservoir for a zoonotic infection of people.
- ❖ For example: the dog, cat, armadillo and opossum that harbours the trypanosome parasite (*Trypanosoma cruzi*) that causes Chagas' disease (American trypanosomiasis) in humans is a reservoir host of the parasite.

Parasitism and Predation Cont'd

- e) **Host Specificity** – the condition where a parasite lives (or has adapted to live) in only one or two species of host and not in any other species.
 - ❖ Host specificity may be absolute (e.g. the pork tapeworm, *Taenia solium* matures only in humans) or low, e.g. the trichina worm, *Trichinella spiralis* is able to mature in almost any warm-blooded vertebrate

Parasitism and Predation Cont'd

- f) **Hyperparasitism** – the situation where a parasite serves as host to another parasite, i.e. a parasite parasitizes another parasite,
- ❖ e.g. the malaria parasite in the mosquito (the female mosquito is parasitic on humans or other vertebrates in that it feeds on their blood to develop its eggs whilst the malaria parasite requires the mosquito for its sexual development stage of its life cycle and for its transmission to humans.

Parasitism and Predation Cont'd

- g) **Multiparasitism** – a condition where an animal or organism is host to more than one species of parasites at the same time;
- ❖ e.g. a human child who has infection with Ascaris and also malaria parasites or infection with worms (different species or single), malaria and trypanosomiasis.

Parasitism and Predation Cont'd

❖ Susceptibility and Resistance

❖ **A host is susceptible** to a parasitic infection if it (the host) is in a physiological state such that it will not eliminate the parasite before the parasite has become established in it (the host).

Parasitism and Predation Cont'd

- ❖ A *host is resistant* if its physiological status prevents the establishment and survival of the parasite in it.
- ❖ Correspondingly, the ability of a parasite to infect a host is termed its **Infectivity** (i.e. the ease or difficulty of a host becoming infected with a particular parasite or with which a parasite is able to infect a host).

SOME ECOLOGICAL AND EPIDEMIOLOGICAL TERMINOLOGY IN PARASITOLOGY

- **Prevalence** is *the ratio of the # of individuals of a host species infected by a parasite to the number of the host species examined.*
- **Usually expressed as a percentage**

Some Ecological and Epidemiological Terms in Parasitology Cont'd

- ❖ **Incidence** is the # of *new cases of a disease or an infection* occurring in a population within a given period to the # of *uninfected individuals* in the population at the beginning of the time period.
- ❖ Usually expressed as a percentage

Some Ecological and Epidemiological Terms in Parasitology Cont'd

- ❖ **Intensity** is the # of individuals (determined directly or indirectly) of a parasite species in an Infected host in a sample.
- ❖ Usually expressed as a numerical range

Some Ecological and Epidemiological Terms in Parasitology Cont'd

- ❖ **Mean Intensity** is *the ratio* the Total # of individuals of a particular parasite species in a sample of a host species to the # of infected individuals of the host species in the sample.

OR

- ❖ The Mean # of individuals of a particular parasite species per infected host in a sample.

Some Ecological and Epidemiological Terms in Parasitology Cont'd

- ❖ **Density** is the # of individuals of a particular parasite species per unit area, volume or weight of infected host tissue or organ.
- ❖ The units should always be clearly specified (e.g. 10mps/ul of blood; 12mf/gm of tissue).

Some Ecological and Epidemiological Terms in Parasitology Cont'd

- ❖ **Density** is the # of individuals of a particular parasite species per unit area, volume or weight of infected host tissue or organ.
- ❖ The units should always be clearly specified (e.g. 10mps/ul of blood; 12mf/gm of tissue). OR
- ❖ ***The Mean # of individuals of a particular parasite species per host examined. OR***
- ❖ ***The Mean intensity (Definition # 4) X Prevalence (Definition # 1)***

Some Ecological and Epidemiological Terms in Parasitology Cont'd

- ❖ **Density - Dependent**
- ❖ In general *Ecology*, this term is used to describe factors or mechanisms whose effects on, or regulation of, populations are a function of the density of the population.
- ❖ In *Parasitology*, this term has been used with reference to factors affecting all individuals of a species of parasite occurring in an individual host.

Some Ecological and Epidemiological Terms in Parasitology Cont'd

- ❖ **Epidemiology** – the science concerned with disease propagation (spread, distribution); it deals with the natural history of the disease
- ❖ (its infection in humans and other animals and
- ❖ the agents which serve as reservoirs and vectors).

Some Ecological and Epidemiological Terms in Parasitology Cont'd

- ❖ **Endemicity** – describes the extent to which a disease is present in a community, area or region.
- ❖ If a disease maintains itself in a human community, it is said to be **ENDEMIC**
- ❖ If there is high prevalence, it is said to be **HYPERENDERMIC**
- ❖ If it is present in unusually high prevalence it is said to be **HOLOENDERMIC**

Some Ecological and Epidemiological Terms in Parasitology Cont'd

- ❖ If the disease appears only occasionally, it is said to be **SPORADIC**
- ❖ If the disease develops a high prevalence through unusually rapid transmission, it is said to be **EPIDEMIC**
- ❖ Corresponding terms for diseases in animals are: **ENZOOTIC, HYPERENZOOTIC, HOLOENZOOTIC, SPORADIC and EPIZOOTIC, respectively.**

Some Ecological and Epidemiological Terms in Parasitology Cont'd

- ❖ **Outbreak** - When an unusual number of infections are acquired simultaneously from the same source and not transmitted from person to person
- ❖ (e.g. Trichinosis infection from eating pork sausage, or cholera from drinking water from a contaminated or sewage-polluted community water source), there is said to be an **OUTBREAK** of the disease.

Means of transmission of Pathogens

- ❖ Pathogens (including parasites) may be transmitted by
- ❖ **Direct contact**
- or by
- ❖ **Indirect Means**

Means of transmission of Pathogens

Cont'd

- ❖ ***Direct Transmission.*** Diseases of humans transmitted mainly by contact include Syphilis and Gonorrhea, diseases of the respiratory tract and other diseases caused by pathogens which may be present in the upper respiratory tract.

Means of transmission of Pathogens

Cont'd

- ❖ Examples of diseases of animals transmitted mainly by direct contact are Brucellosis and Hog cholera.
- ❖ The meat or milk of an infected animal may be used as food by a human being or other animal and thus transmit the pathogens directly.
- ❖ Thus diseases which may be transmitted by direct contact may also be spread by other means.

Means of transmission of Pathogens

Cont'd

Indirect Transmission.

- ❖ This requires a **vehicle or carrier (VECTOR)** for the transmission of the pathogen.
- ❖ The vehicle which carries the pathogen may serve only as a mechanical means of transmission or it may play an active part in the process.
- ❖ The vehicle **may be an inanimate substance, or it may be a living organism.**

Means of transmission of Pathogens

Cont'd

- ❖ Air is an important and temporary carrier of pathogens suspended in moisture droplets.
- ❖ It is also possible for pathogens to be transmitted by FOMITES
- ❖ (inanimate objects such as clothing, bedding, books, money, eating and drinking utensils, feed sacks, hair combs, etc.)

Means of transmission of Pathogens

Cont'd

- ❖ **Arthropods** (such as lice, ticks, fleas, flies, and mosquitoes) may serve as accidental carriers of pathogens, or in some cases as active, intermediate hosts for the organisms.
- ❖ Flies, for example, may carry pathogens on their legs or in their digestive tract, and thus serve as mechanical vectors without becoming infected.

Means of transmission of Pathogens

Cont'd

- ❖ The *Aedes* mosquito may suck blood from an individual infected with the yellow fever virus and transmit the virus to a healthy individual.
- ❖ Similarly, lice ticks and fleas may transmit pathogens from one person to another or from an infected animal to a human being.

Means of transmission of Pathogens

Cont'd

- ❖ In the case of the malaria parasite, the *Anopheles* and certain other mosquitoes serve as the **vectors** in which the parasite, *Plasmodium spp.*
- ❖ undergo part of their life cycle.

Means of transmission of Pathogens

Cont'd

- ❖ The first proof that arthropods could serve as vectors of disease was presented by
- ❖ Smith and Kilborne in the early 1890s when they demonstrated that a tick served as the vector for the spreading of the protozoan parasite which causes Texas fever in cattle.

PARASITISM AS A MODE OF LIFE BY PARASITES

- ❖ Although the term suggests that the parasite is harmful to its host
- ❖ A parasite seeks a delicate equilibrium with its host so that each tolerates the other
- ❖ (the death of the host is detrimental to the parasite; however, compare with the mode of life of a Parasitoid)

- ❖ If the balance is upset the host may spontaneously expel or destroy the parasite, or the host may succumb to the infection
- ❖ To achieve its objectives, a parasite is adapted to live in/prefer specific niches, habitats or environments, on or within, its host.

Niches, Habitats and Environments of Parasites on or within the host.

- ❖ Parasitology is essentially a branch of Ecology in which the habitat and environment of an organism (the parasite) is provided by another organism (the host).

Niches, Habitats and Environments of Parasites on or within the host cont't

- ❖ Two different species of parasites can occupy the same habitat
- ❖ (e.g. the intestines of an animal) while occupying different niches because one may use glucose for nutrition, whereas the other uses fructose-the two organisms thus occupy different nutritional niches

Niches, Habitats and Environments of Parasites on or within the host cont't

- ❖ A vast range of niches/ habitats/ environments are, therefore, available for occupation by parasites
- ❖ In Invertebrates, the possible habitats include:
 - ✓ Most tissues
 - ✓ Reproductive system

Niches, Habitats and Environments of Parasites on or within the host cont't

In Vertebrates the habitats include:

- ❖ Alimentary Canal
- ✓ Though most hazardous
- ✓ Dark
- ✓ Undergoes regular physiological changes relative to the feeding habitats of the host.

Niches, Habitats and Environments of Parasites on or within the host cont't

- ❖ Contains a battery of proteins, fats and carbohydrate-splitting enzymes
- ❖ pH of wide range
- ❖ almost oxygen-free
- ❖ may undergo violent movements
- ❖ varied topography e.g. size of villi, width and depth of crypts

Niches, Habitats and Environments of Parasites on or within the host cont't

- ❖ the most popular sites for intestinal parasites are the:
 - duodenum
 - ileum
 - large intestine

Niches, Habitats and Environments of Parasites on or within the host cont't

Blood

- ❖ Quantity of soluble food varies with the feeding habitat of the host
- ❖ Relatively poor medium for Cestodes in search of absorbable molecules such as amino acids, glucose, etc. compared to the duodenum
- ❖ A trematode, e.g. *Schistosoma* with a gut and well-developed digestive enzymes is able to obtain its nutritional needs in the blood

Niches, Habitats and Environments of Parasites on or within the host cont't

Skin

- ❖ Habitat for mostly ectoparasites and some arthropod parasites

Niches, Habitats and Environments of Parasites on or within the host cont't

Tissue / Organs

- ❖ Inhabited by some protozoans, helminths (particularly nematodes)

Reproductive Potential of Parasites

- **This is determined by the**
 - ❖ Need to produce offspring to infect the next host
 - ❖ Hence complete life cycles evolved, involving intermediate hosts and a definitive host

Reproductive Potential of Parasites

cont'd

- Large numbers of offspring (to make up for losses in hazardous environment)
- e.g. reproduction by multiple fission or schizogony in parasitic protozoa
- a continuous replication of reproductive organs (strobilation) in tapeworms

Reproductive Potential of Parasites

cont'd

- ❖ solving the problem of mate-finding by possession of male and female reproductive systems (hermaphroditism), e.g. in tapeworms
 - ❖ production of numerous eggs
- ✓ e.g. the rat tapeworm, *Hymenolepis diminuta*
- ✓ the common roundworm, *Ascaris*

Reproductive Potential of Parasites

cont'd

- ❖ Asexual reproduction by simple mitotic fission, e.g. in many protozoan parasites such as *Plasmodium sp.* (the cause of malaria).
- ✓ Also, the digenitic trematodes (e.g. the flukes (*Schistosoma*, *Fasciola*) with a series of reproductive stages, each multiplying the generation.

Reproductive Potential of Parasites

cont'd

❖ Production of resistant stages such as:

✓ Cysts

✓ Spores