DEBRE MARKOS UNIVERSITY
COLLEGE OF AGRICULTURE AND NATURAL RESOURCE
PROGRAM: *ANIMAL SCIENCE*

Course Title: ***Animal Health and Disease Control (Vetm 3103)*** **3 credit hours**

Chapter one

1. General Concept of disease (infection) and its importance

Disease is defined as an alteration of the state of the body, or of some of its organs, which interrupts the proper performance of the body functions. According to the causative agent diseases can be classified in to: -

I. Infectious disease: The word "infection" is derived from the Latin "inficere", meaning "to put into" or "to dip into, to stain". In the most exact sense, infection implies the presence of microorganisms in or on the body of the host. Therefore an infectious disease is one that is caused by the presence in or on an animal body of a foreign living organism, which creates a disturbance leading to the development of signs of illness.

II. Non-infectious disease: It is a disease, which is caused by non-living agents or factors like injury, plant or animal poison, cold, excessive heat or faulty nutrition.

1.1. Basic terminologies used to study Infectious Diseases.

Infectious diseases are those diseases caused by organisms (such as bacteria, viruses, rickettsiae, fungi and protozoa) and which are capable of passing from infected to healthy one under favourable conditions. In other words, infectious diseases are the result of the invasion of a host by a pathogenic organism.

Contagious disease is a disease that is caused by an organism, which is readily transmitted, from one individual to another by direct or indirect contact.

Non-contagious disease is one that does not transmitted by contact.

The term infectious and contagious diseases are used interchangeable. It is best, however, to limit the terms. Infectious defines the cause of the disease and contagious indicates the method of disease transmission. All contagious diseases are infectious but all infectious diseases are not contagious.

Infection: invasion of pathogenic microorganisms into body tissues so that the tissues are affected and altered.

- **Inapparent (Silent)/ Sub-clinical infection** - This is infection of a susceptible host without showing clinical signs. The inapparently infected animal poses a considerable problem to the disease controller because it is impossible to detect without auxiliary diagnostic aids. And also causes great loss of productivity.
- **Clinical Infection**: - This type of infection produces clinical sign or disease.

1.2. Host and agent interaction/ relationships

The relationships between infection and disease are frequently dynamic in nature. They centre on the "balance" that can be achieved between the resistance mechanism of the host and the infectivity and virulence of the agent. Disease outbreaks caused by the introduction of an agent into a susceptible host population which has not been previously exposed to that agent normally result in a disease of high pathogenicity with commensurate severe losses in the host population. Such a process is actually detrimental to the agent's survival, since by killing off the host population it adversely affects both its ability to reproduce and its chances of gaining access to new susceptible hosts. An agent can therefore improve its chances of survival by increasing its infectivity and decreasing its pathogenicity, and some agents have a natural tendency to do this under certain circumstances. Since a commensal or parasitic relationship confers no benefits to the hosts, they tend to develop means of resisting infection by disease agents. While the agents, in order to survive, develop methods of circumventing the hosts' defences. Disease agents normally have much shorter generation intervals and can multiply much more rapidly than their hosts, and therefore tend to evolve much quicker. This rapid evolution usually enables the agents to keep comfortably ahead of the hosts' defence mechanisms.

There are many mechanisms by which infectious agents can avoid or overcome the defences of the host. The two mechanisms whose consequences are of particular importance in the field of livestock disease control are the carrier state and antigenic variation.

Creation of the carrier state:- The term "carrier" is used to describe an individual that is infected by a disease agent and is capable of disseminating that disease agent but shows no sign of clinical disease. Three types of carrier state are recognized: **The true carrier**, which is an infected individual capable of disseminating the infectious agent but which never exhibits clinical signs of disease. True carriers occur in various diseases, including salmonellosis.

The incubatory carrier, which is an infected individual capable of disseminating the infectious agent while the disease is still in the incubatory stage. In foot-and-mouth disease, for instance, infected animals are most infectious 12 to 24 hours before the clinical signs of the disease appear. **The convalescent carrier**, which is an individual that continues to disseminate the infectious agent after the clinical signs of the disease have disappeared. Convalescent carriers occur in such diseases as contagious bovine pleuropneumonia.

Other terms used to further define host/agent relationships include: **Incubation period**, which is the period of time that elapses from the infection of the host by the agent to the appearance of clinical symptoms. **Prepatent period**, which is the period between the infection of the host by the agent and the detection of the agent in the tissues or secretions of the host. **Period of communicability**, which is the period of time during which an infected host remains capable of transmitting the infective agent.

1.3. Factors influencing the occurrence of diseases (disease determinates)

A determinant is any factor or variable that can affect the frequency with which a disease occurs in a population. Determinants can be broadly classified as being either intrinsic or extrinsic in nature. Intrinsic determinants are physical or physiological characteristics of the host or disease agent (or intermediate host or vector, if present) which are generally determined genetically. Extrinsic determinants are normally associated with some form of environmental influence on the host or disease agent (or intermediate host or vector, if present). They may also include interventions made by man into the disease process by the use of drugs, vaccines, dips, movement controls and quarantines. For the establishment of infectious diseases the interaction of host, agent and Environment plays a vital role. For example environmental mastitis involves the interaction between Escherichia coli or streptococcus uberis (the agent), milking machine faults, and poor hygiene resulting from inadequate bedding, drainage and cleaning of passage ways (the Environment). In addition cows (the hosts) are most susceptible in early lactation.

Factors associated with the host (Intrinsic factors)

The main intrinsic determinants in the host are species, breed, age and sex.

Species susceptibilities and natural reservoirs: Most disease agents are capable of infecting a range of animal species, both vertebrate and invertebrate. The severity of the disease resulting from such infections may, however, vary between the species concerned. While certain host species may be refractory to infection with certain disease agents, e.g. equines to the foot-and-mouth disease virus, very few disease agents are in fact restricted to one host species. The multi-species susceptibility to disease agents is particularly important if the species concerned are able to maintain the disease agent within their populations i.e. to function as natural reservoirs of infection. The failure of programmes aimed at controlling a certain disease in one species has often been blamed on the presence of natural reservoir species, because they can reintroduce the infectious agent. When investigating the potential of a certain species to act as a natural reservoir of a particular disease agent, and the implications on disease control policy, the following considerations need to be borne in mind:

Infection with the disease agent:- Although it may be possible to infect a certain host species with a disease agent under laboratory conditions, this may only be achievable by using a method of transmission that does not occur naturally. If this is the case, that particular host species is unlikely to play a significant role in the epidemiology of the disease.

Ability of a host species to maintain a disease agent:- It may prove possible to demonstrate that a particular host species can be infected by a certain disease agent and that infection can be accomplished by a natural means of transmission. A further question then needs to be asked, namely, is that species capable of maintaining the agent within its populations for significant periods of time? If this is not the case, then although that particular species may be involved in the localized spread of the disease agent during an outbreak, it will not serve as a continuous source of infection.

Transmission from the natural reservoir:- Even if a species can function as a natural reservoir for a particular disease agent, transmission from that reservoir to domestic livestock may only occur rarely and in certain, clearly defined circumstances. If this is the case, the reservoir species is unlikely to cause a major problem in the initial control of the disease in question. However, when the frequency of occurrence of the disease has been reduced to a low level, and eradication

of the disease becomes a possibility, the implications of the presence of reservoir host species for the success of the proposed eradication programme may have to be re-assessed.

Breed susceptibilities: Within a host species, wide ranges of susceptibility to a particular disease are often observed between different breeds. In Africa, for example, certain breeds of cattle, horses, sheep and goats are more tolerant of trypanosomiasis than others. Bostaurus breeds of cattle are generally more susceptible to ticks and tick-borne diseases than Bosindicus. It is important, however, to distinguish between the differences in susceptibility that are genuinely related to breed or species and the differences that may arise as a result of previous exposure to infection. Breeding for disease resistance is probably most applicable as a disease control option in instances where particular disease agents are ubiquitous in the environment, or of non-infectious diseases caused by multi-causal determinants, or where other methods of control have proved unsatisfactory. Differences in species or breed susceptibility to disease must be taken into account when introducing new breeds or species into new environments. The new breed or species may be exposed to disease agents to which the new breed or species is highly susceptible. Conversely, the imported breed or species may itself introduce a new disease agent to which it is resistant but to which local breeds or species are susceptible. This factor has become the cause for much concern in recent years given the rapid development of international transport facilities whereby livestock and their products can easily be conveyed from one part of the world to another.

Age susceptibilities: Differences in susceptibility to disease are often seen between different age groups. For example, young animals are generally less susceptible to tick-borne diseases than older animals. There is, however, often a problem in distinguishing between true age resistance in young animals and passive resistance occasioned by the transfer of maternal antibodies via the placenta or in the colostrum.

Sex associations in disease: In these associations the clinical signs of disease are associated with sexual attributes, as in the case of diseases of the reproductive tract, rather than with the fact that males may be more susceptible than females or vice versa.

Factors associated with disease causing agents (Extrinsic factors)

Agents associated with disease can be categorized into two broad groups:"Living" agents, such as viruses, bacteria, rickettsia, protozoa, helminths, arthropods etc. "Non-living" agents, such as heat and cold, water, nutrients, toxic substances etc. In instances of infectious disease, the presence or absence of the etiological agent is the main determining factor in the epidemiology of the disease. Obviously, disease cannot occur in the absence of the agent, but, conversely, disease need not always result from the presence of the agent. This leads us to the important epidemiological distinction between infection and disease

Infectivity, virulence and pathogenicity

Whether infection takes place or not may depend on a whole range of determinants, both intrinsic and extrinsic, which affect the host and the agent (and the intermediate host or the vector, if present). **Infectivity** is a measure of the ability of a disease agent to establish itself in the host. This term can be used qualitatively, when an agent is referred to as being of low, medium or high infectivity, or quantitatively. Having become infected, the host may or may not become diseased, and this is again determined by a range of intrinsic and extrinsic determinants affecting the agent and the host. **Two terms - virulence and pathogenicity** - are often used to describe the ability of the agent to cause disease. **Virulence** can be defined as a measure of the severity of a disease caused by a specified agent. In its strict sense, virulence is a laboratory term and is used to measure the varying ability of disease agents to produce disease under controlled conditions. It is often quantified by a statistic known as LD_{50}. **Pathogenicity** is an epidemiological term used to describe the ability of a particular disease agent of known virulence to produce disease in a range of hosts under a range of environmental conditions.

Environmental Factors (Extrinsic factors)

Extrinsic determinants of disease are important in epidemiology in that they can have effects on the host, on the agent, and on the interactions between the host and the agent. They can also affect any intermediate hosts or vectors involved in the transmission of a disease, and thus determine the type and extent of the disease transmission taking place. There are three major extrinsic determinants. The first two are climate and soils, which, by interacting in a variety of ways, affect the environment of the host, the agent, and the intermediate host or vector, if they

are present. The third major factor is man, who, uniquely among animals, has the ability to modify both the environment in which he lives and the environment in which he keeps his livestock.

Physical factors: Climate (macroclimate: terrestrial and microclimate: biological)

Climate: When considering climate as a determinant of disease, a distinction is normally made between the macroclimate or weather, and the microclimate. The term microclimate refers to the actual climatic conditions prevailing in the specific, restricted environment where the host, agent, vector or intermediate host actually lives. While man is as yet largely incapable of deliberately manipulating macroclimates, he can control and manipulate microclimates to some extent.

Macroclimates: A large number of different factors combine to make up the microclimate. Some of these factors (heat, cold, rainfall, wind, humidity etc) can act as disease agents in their own right, either individually or in combinations. As such they can cause disease in young and newborn animals which are particularly sensitive to heat, cold and dehydration. In older animals they tend to act more as indirect determinants of disease in that they can produce either alone or in combinations with other managemental and nutritional determinants - "stress" conditions in the host, which may lower its resistance both to infection and, if infection takes place, to disease. Microclimates. While macroclimates can have a direct effect on microclimates, the study of macroclimates alone can frequently be misleading in achieving an understanding of the epidemiology of a disease. Regions where existing macroclimatic conditions might be thought unsuitable for the transmission of a disease may, in fact, contain limited areas where the microclimatic conditions are suitable for the survival of the disease agent and its vector or intermediate host. (An example may be a water hole or an irrigated pasture in an arid environment). Such areas often provide enhanced conditions for disease transmission, since the host and the agent (and the vector or intermediate host, if they exist) are in close contact, the transmission of disease can be effected rapidly and easily.

Soils: By interacting with climate, soils determine vegetation and the environment in which the livestock are kept. The main effect of vegetation is on nutrition. Soils therefore act indirectly as determinants of disease by causing starvation, if there is little or no vegetation, or nutritiorial imbalances such as protein, energy, vitamin or mineral deficiencies. Malnutrition can be the

direct cause of disease, or it can stress the host and thus increase its susceptibility to infection and disease from other sources. Soils can also have an effect on the ability of the agent to survive in the environment, through such factors as water logging, pH etc.

Man: Man is often able to create favourable, artificial microclimates for livestock rearing by providing such inputs as housing, water supplies, irrigation etc. Unfortunately, this often results in the creation of conditions favourable for the survival of disease agents and their intermediate hosts or vectors. This means that, by altering the environment, man can alter the determinants of the diseases present in that environment. The changes in determinants will favour some diseases and be detrimental to others. Man is also able to interfere directly in the disease process through the use of drugs, vaccines, movement controls, quarantines etc.

Husbandry: Housing, Diet and Management (reading assignment)

1.4. Patterns of Disease Occurrence

Endemic Occurrence - It is a special form of infectious disease occurrence in which disease is retained for a long time in some locality and affecting a large number of animals of a particular species or breeds. So, ' endemic' is used to describe a constant presence of a disease in a population.

Epidemic Occurrence- It is the occurrence of an infectious or non- infectious disease to a level in excess of the expected (i.e. endemic) level

Pandemic Occurrence - It is a widespread epidemic that usually affects a large proportion of the population. Many countries can be affected.

Sporadic Occurrence - It occurs irregularly and haphazardly. This implies that appropriate circumstances have occurred locally producing small, localized outbreaks.

1.5. Methods of disease transmission

Ascertaining the means by which disease agents are transmitted is a major objective since once the mechanisms by which a particular disease is transmitted are understood, it may become possible to introduce measures to prevent transmission from taking place. There are three main ways by which disease agents are transmitted from infected to susceptible hosts. An agent may be transmitted through contact between infected and susceptible individuals, or it may be conveyed between these individuals by means of an inanimate object or via another animal

serving as a vector or intermediate host. These methods of transmission are not mutually exclusive; the same disease agent may be transmitted by more than one of the following ways.

Contact transmission:- In contact transmissions the agent is conveyed between hosts through direct physical contact, as in the case of venereally transmitted diseases such as vibriosis or trichomoniasis, or through indirect contact. In cases of indirect contact the agent is normally contained in the excretions, secretions or exhalations of the infected host i.e. in the faeces, urine, milk, saliva, placenta and placental fluids, or as aerosols or droplets in the breath. Susceptible hosts contract the infection either by direct exposure to these or through exposure to substances contaminated by them. Diseases spread in this fashion include FMD, Newcastle disease, and CBPP.

Contact transmissions can be further distinguished according to whether they occur horizontally between individuals of the same generation or vertically between individuals of different generations. In vertical transmissions the infectious agent is usually passed from dam to offspring either in the uterus or through the colostrum. Main factors determining whether or not transmission takes place in contact-transmitted diseases are:

- The ability of the agent to survive in the environment. Foot-and-mouth disease can spread between widely separated stocks.
- The extent of the contact that occurs between infected and susceptible individuals of the host populations and their mobility within these populations. The control of livestock movements is, therefore, a vital factor in the control of contact-transmitted diseases which, in Africa, normally occur more frequently during the dry season when livestock movements are at their highest.

Vehicular transmission:- In vehicular transmission the agent is transferred between infected and susceptible hosts by means of an inanimate substance or object (sometimes called fomite), such as water, foodstuffs, bedding materials, veterinary equipment and pharmaceuticals, or on the skin, hair or mouthparts of animals. In contrast to indirect transmission, the survival time of the agent in or on the vehicle is usually prolonged. This means, in effect, that vehicular transmission can take place over greater distances and over longer time periods. Hygiene, disinfection and control over the distribution of likely vehicles of transmission are important factors in the control of vehically transmitted diseases. Certain agents may take the opportunity

to reproduce themselves during vehicular transmission. This occurs in the transmission of food-borne bacteria, such as salmonella and coliforms, and underlines the importance of strict hygiene in the handling of foodstuffs and livestock feeds, since a small initial contamination may eventually result in the gross contamination of a whole batch of food or feed.

Vectors and intermediate hosts:- Confusion frequently arises between the terms "vector", "intermediate host" and "definitive host". The latter two terms are essentially parasitological terms and describe the different types of hosts that are biologically necessary in the lives of agents with relatively complicated life cycles. A vector is an invertebrate animal that actively transmits an infectious agent between infected and susceptible vertebrates. Essentially, vectors can transmit infectious agents in two ways. They can serve as a vehicle whereby the infectious agent is conveyed from one host to another without undergoing a stage of development or multiplication. This is known as mechanical transmission. In mechanical transmission the agent is carried on the skin or mouthparts of the vector from an infected to a susceptible host. The survival time of the agent in or on the vector is usually short, and as a result the transmission of the agent has to be accomplished rapidly. Alternatively, the infectious agent can undergo some stage of development or multiplication in the vector - this is known as biological transmission - and in this case the vector is serving either as an intermediate or definitive host, depending on which stage of the development cycle of the agent takes place within it. Vertebrate intermediate hosts play the same role in the transmission of their disease agents as biological vectors. In biological transmission, since the agent develops in the vector, a period of time elapses between the acquisition of the infectious agent by the vector and its becoming infective. Once it has become infective, the vector may remain so, normally for a considerable period if not the rest of its life. This provides more than a single opportunity for disease transmission.

In addition, vectors may be able to pass the agent on to their own offspring transovarially. Transovarial transmission enables an infectious agent to be maintained in a vector population through many generations without that population having to be reinfected, and, as such, the vector population remains a continuous source of risk. Arthropod vectors that undergo metamorphosis have the capacity to pass an agent from one developmental stage to the next. This is known as transtadial transmission. Usually in transtadial transmission, one developmental stage becomes infected with the disease agent and the following stage transmits it. If different

developmental stages feed on different host species, transtadial transmission can provide a mechanism for an inter-species transmission of disease agents.

1.6. Disease Control Measures

Control: is the reduction of the morbidity and mortality from diseases, and is a general term embracing all measures intended to interfere with the unrestrained occurrence of disease, whatever its cause.

Methods of Control

1.**Quarantine** - It is the isolation of animals that are either infected or suspected of being or non-infected animals that are at risk. Quarantine is used to isolate animals when they are imported from countries where exotic diseases are endemic. In this case suspected animals are isolated until infection is either confirmed or discounted.

2. **Creation of unfavourable environment:** this may be related to the livestock or the environment. For instance tolerance- only animals that are resistant to the organism may be kept in the area. E.g. N`dama cattle tolerant to trypanosomosis.

3. **Disinfection-** it involves the destruction of pathogenic organisms on inanimate objects, usually by physical or chemical means. All disinfectants are effective against the vegetative forms of organisms but not necessarily against the spore form of the organisms.

4. **Immunization** - It is the process by which antibody is produced or administered for the prevention or treatment of disease. Generally, there are two types of immunity.

a) Natural immunity - It is attributed to antibodies present or appearing without obvious external stimulus.
b) Acquired immunity- is that which an animal develops or receives at any time after birth.

- Active immunization-follows actual injection and also artificial stimulation with living or attenuated microorganisms, dead organisms or their components or products.
- Passive immunization- is the result of natural transfer of antibodies from the mother to the fetus or newborn animal or the injection of antitoxins and other antisera.

5. **Stamping out** – It is killing animals that are affected, suspected of being affected in the herd and comes in a direct or indirect contact with affected animals. All susceptible animals, vaccinated or unvaccinated, on an infected premises should be killed and the carcasses destroyed by burning or burial, or by any other method which will eliminate the spread of infection through the carcasses or products of the animals killed.

6. **Control of vectors:** vectors are contributory factors for disease occurrence. They are prevented from invading or eliminating by the application of suitable control measures. For vector control you can use insecticide or acaricide.

Assignment and Home study #1, from Chapter-1 of this hand out and the given reference (20-Point)

Q1. Clearly state the difference between disease and infection?

Q2. What are the main constraints of farm animal's production and productivity?

Q3. What is the difference between Etiology and cause of a disease?

Q4. There are different periods after the causative agent gains entry to the host/animal (infection) till the animal becomes died or recovered. Write in detail those periods?

Q5. Source of an infectious disease can be classified as primary and secondary sources. List and discuss in detail about those sources of a disease to the native host?

Q6. Routs of infection are site/s by which pathogens enter and leave the host (in this case the animal). Discuss in detail about the routes and modes of disease transmission?

Q7. Determinant of disease occurrence can be seen as three major categories.

- What is disease determinant?
- Discus clearly about the 3 major categories of disease determinant (Epidemiological triads)?