CHAPTER 2

Animal Diseases

2.1 Introduction

Infectious diseases of animals mainly farm animals, pet animals, laboratory animals, zoo animals and wild animals are of concern to human because of their importance economically as they cause hazards to the public. Animal diseases that people can catch are called zoonoses. About 75 percent of the new diseases affecting human in the past decade can be traced to animal or animal products. Human can get a disease directly from an animal, or indirectly, through the environment. Diseases associated with immunosuppressant were discussed by Eugene R. Heise (1). Imperilments of any of the major components of the immune system (T - cells, B- Cells, phagocytes, complement) may result in clinical immunodeficiency. Immune defects can arise from intrinsic or inheritable defects of lymphoid elements, failure of normal cellular differentiation, viral infection or other acquired causes.

2.2 Types of animal diseases

Many Bacterial and Viral diseases affect the livestock and poultry. Effective control of animal diseases is a critical element of any strategy that aims at supporting and enhancing livestock dependent livelihoods of rural poor. Anthrax, caused by Bacillus anthracis affects human and domestic animals. Resistant spores that are carried in the hair or hides of animals or in
floodwaters explain the sudden appearance of this bacterial disease. This disease often takes a very rapid course. It begins with a high fever, followed by diarrhoea with blood. The animal dies within two days.

A total of five diseases, Haemorrhagic Septicaemia (HS), Peste des Petits Ruminants (PPR), Black Quarter (BQ), Enterotoxaemia (ET) and Newcastle Disease (ND) are identified as those probably having the highest impact on poor livestock keepers. Haemorrhagic Septicaemia is an endemic in most parts of India and seasonal outbreaks are an annual feature. Andhra Pradesh ranks first in the total number of HS attacks reported in India followed by Gujarat and Karnataka. Black Quarter, a soil-borne clostridial infection of bovines, is ranked fourth in terms of economic importance as disease of livestock in India. It is most frequent in the states of AP and Karnataka. The survival of clostridial spores in different soil types is not well understood and there seems to be some relationship between the soil type and number of rainy days for BQ to precipitate in a given location. Frequent soil contamination with infective spores due to poor carcass disposal adds to build-up of soil infection. Newcastle disease, a virus infection of domestic poultry and wild free-living birds, is widespread in India. There is limited 'carrier status' in recovered and apparently healthy birds, especially in free-living wild birds, which are the source of infection to rural, domestic birds. The disease produces moderate morbidity and mortality in rural poultry, which are somewhat resistant to the virus infection (2). The various types of diseases are discussed.
2.2.1 Bacterial diseases

Bacteria are living things that are neither plants nor animal, but belong to a group all by themselves. They are very small, individually not more than one single cell however there are normally millions of them together, for they can proliferate rapidly. Bacteria can live in animal and in the environment. Not all bacteria can cause disease. Human and animals have bacteria living on and in them that do not cause disease. Diseases in animal caused by bacteria are anthrax, black quarter and tuberculosis. Bacteria can infect wounds, and that is why wounds should be treated.

Bacteriology is the study of bacteria, including their classification and the prevention of diseases that arise from bacterial infection. The subject matter of bacteriology is distributed not only among bacteriologists but also among chemists, biochemists, geneticists, pathologists, immunologists and doctors.

History of Bacteria

Bacteria (in Greek bakterion means “little staff”) are a large group of mostly microscopic, unicellular organisms that lack a distinct nucleus and usually reproduce by cell division. Dividing Bacteria upon reaching a critical size and metabolism, bacteria and other cells divide to form two identical daughter cells with approximately half of the original cell’s mass, which themselves begin to grow. A bacterium may divide as often as every 20
minutes, very quickly forming a colony that is visible to the human eye. Bacteria are tiny, most ranging from 1 μm to 10 μm (1 μm = 10^{-6} m) and are extremely variable in the ways they obtain energy and nourishment. They can be found in nearly all environments from air, soil, water, and ice to hot springs, even the hydrothermal vents on the deep ocean floor are the home of sulphur-metabolizing bacteria. Certain types are found in nearly all food products, and bacteria also occur in various forms of symbiosis with most plants and animals and other kinds of life.

Bacteria were first observed by the Dutch naturalist Anton van Leeuwenhoek with the aid of a simple microscope of his own construction. He reported his discovery to the Royal Society of London in 1683, but the science of bacteriology was not firmly established until the middle of the 19th century. For nearly 200 years it was believed that bacteria are produced by spontaneous generation. The efforts of several generations of chemists and biologists were required to prove that bacteria, like all living organisms, arise only from other similar organisms. This fundamental fact was finally established in 1860 by the French scientist Louis Pasteur, who also discovered that the process of fermentation and many infectious diseases are caused by bacteria. The first systematic classification of bacteria was published in 1872 by the German biologist Ferdinand J. Cohn, who placed them in the plant kingdom. They are now usually included in the kingdom Monera. In 1876 Robert Koch, who had devised the method of inoculating bacteria directly
into nutrient media as a means of studying them, found that a bacterium was the cause of the disease anthrax.

Since 1880, immunity against bacterial diseases has been systematically studied. In that year, Pasteur discovered by accident that Bacillus anthracis, cultivated at a temperature of 42° to 43° C (108° to 110° F), lost its virulence after a few generations. Later it was found that animals inoculated with these enfeebled bacteria showed resistance to the virulent bacilli. The prevention, modification, and treatment of disease by immunization, one of the most important modern medical advances, date from this beginning.

Many organisms have adapted to survival in environments with different nutrient sources and physical conditions and they have evolved to include mechanisms to sense their environment and produce components appropriate to the specific conditions. A classic example of this is growth under conditions where free iron is limited. Gram-negative organisms adapt to grow in the absence of free iron by producing a number of novel proteins on their surface which are able to sequester iron from host iron-binding proteins such as transferrin, lactoferrin, haeme compounds and others (3 - 6). Members of the Pasteurellaceae are excellent examples of this phenomenon (7 - 11) and a number of groups have demonstrated that vaccines enriched in these novel proteins were capable of inducing enhanced protection following immunization (12 -14).
Classification

Although many forms of bacteria are not capable of independent movement, species such as the Salmonella bacterium pictured here can move by means of fine thread-like projections called flagella. The arrangement of flagella across the surface of the bacterium differs from species to species; they can be present at the ends of the bacterium or all across the body surface. Forward movement is accomplished either by a tumbling motion or in a forward manner without tumbling (15).

In the currently used five-kingdom scheme of classification, bacteria constitute the kingdom Monera, also known as Prokaryotae—organisms in whose cells the nucleus is not enclosed by a membrane. About 1,600 species are known. Generally, bacteria are classified into species on the basis of characteristics such as shape—cocci (spheres), bacilli (rods), spirochaetes (spirals); cell-wall structure; differential staining (Gram's Stain); ability to grow in the presence or absence of air (aerobes and anaerobes, respectively); metabolic or fermentative capabilities; ability to form dormant spores under adverse conditions; serologic (serum) identification of surface components; and nucleic-acid relatedness.

Pathogenic Bacteria

About 200 species of bacteria are pathogenic, or disease-causing, for humans. Pathogenicity varies widely among various species and is dependent
on both the virulence of the particular species and the condition of the host organism. Among the more invasive bacteria responsible for human disease are those that cause cholera, tetanus, gas gangrene, leprosy, plague, bacillary dysentery, tuberculosis, syphilis, typhoid fever, diphtheria, undulant fever, and several forms of pneumonia. Until the discovery of viruses, bacteria were considered the causative agents of all infectious diseases.

**Culture**

A fundamental method of studying bacteria is by culturing them in liquid media or on the surface of media that have been solidified by agar. Media contain nutrients, varying from simple sugars to complex substances such as meat broth. To purify or isolate a single bacterial species from a mixture of different bacteria, solidified media are generally used. Individual cells dividing on the surface of solidified media do not move away from each other as they do in liquid, and after many rounds of replication they form visible colonies composed of tens of millions of cells all derived by binary fission from a single cell. If a portion of a colony is then transferred to a liquid medium, it will grow as a pure culture, free of all other bacteria except the single species that was found in the colony.

Many different species of bacteria so closely resemble one another in appearance that they cannot be differentiated from one another under the microscope. Various culture techniques have been developed to aid species
identification. Some media contain substances to inhibit the growth of many bacteria, but not the species of interest. Others contain sugars that some but not all bacteria can use for growth. Some media contain pH indicators that change colour to indicate that a constituent of the media have been fermented, yielding acid end products. Gas production as an end product of fermentation can be detected by inoculating bacteria in solidified media in tubes rather than on plates. Sufficient gas production will result in the formation in the agar of bubbles that can easily be seen. Still other media are formulated to identify bacteria that produce certain enzymes that can break down constituents in the media; for example, blood agar plates, which can detect whether bacteria produce an enzyme to lyse, that is, dissolve red blood cells. The various culture media and culture techniques are essential to the hospital laboratory, whose job it is to identify the cause of various infectious diseases.

Sterilization

Drying or freezing kills many species of bacteria and causes others to become inactive. Heat kills all bacteria. Sterilization of objects such as surgical instruments is important facets of bacteriological work.

Microscopic Examination

The microscope is one of the most important tools used in studying bacteria. Dyeing or staining bacterial specimens or cultures was introduced in 1871 by the German pathologist Karl Weigert and has greatly helped the
bacteriologist in identifying and observing bacteria under the microscope. A bacterial specimen is first placed on a glass slide. After the specimen has dried, it is stained to render the organism easier to observe. Stains also stimulate reactions in certain bacteria. For example, the tuberculosis bacillus can be recognized only on the basis of its reaction to certain stains, such as Gram's stain. Bacteriologists have been greatly aided by the electron microscope, which has far stronger magnification powers than ordinary microscopes.

*Gram's Stain*

Gram's Stain, widely used method of staining bacteria as an aid to their identification, devised by Hans Christian Joachim Gram, a Danish doctor. In Gram's method, bacteria are first stained with gentian violet (a dye consisting of a methyl derivative of pararosaniline) and then treated with Gram's solution, consisting of 1 part iodine, 2 parts potassium iodide, and 300 parts water. After being washed with ethyl alcohol, the bacteria will either retain the strong blue colour of gentian violet or be completely decolorized. Sometimes a counter stain such as fuchsin or eosin is applied to give the decolorized bacteria a red colour to make them more visible.

Bacteria that retain the blue stain are known as gram-positive; those that do not are known as gram-negative. Organisms that sometimes retain the blue colour and sometimes do not are known as gram-variable. Typical gram-
positive bacteria are those staphylococci that produce boils; typical gram-
negative bacteria are the bacilli that cause whooping cough; typical gram-
variable bacteria are the bacilli that cause tuberculosis.

Current Research

In recent years, bacteriology has been greatly expanded from its
concentration on disease-causing pathogens. The discovery of nitrogen
fixation by bacteria (in the root nodules of leguminous plants) has led to
attempts to inoculate the roots of other plant strains and thereby increase soil
fertility and the productivity of food crops. Some bacteria are able to digest
petroleum and other hydrocarbons; others absorb phosphorus. These bacteria
are being intensively investigated as possible aids in cleaning up oil spills and
removing phosphorus from sewage sludge. Other bacteria may be more
efficient than yeast at producing alcohol and are being explored in the search
for new energy sources.

Bacteria cause disease in several ways. Some produce powerful
poisons or toxins; for example, the botulinus bacillus, the tetanus bacillus, and
the gas gangrene bacillus. Other bacteria cause local or general death of body
tissues, block the flow of blood, or cause severe irritation. Leptospirosis, due to spiral bacteria of the genus Leptospira, affects cattle,
dogs, and human. Ponds, lakes, and other bodies of water are common
sources of leptospirosis.
2.2.2 Viral Diseases

Virology

Virology is the study of viruses and virus-like agents, their structure, classification and evolution, their ways to infect and exploit cells for virus reproduction, the diseases they cause, the techniques to isolate and culture them, and their use in research and therapy. Virology is often considered a part of microbiology or of pathology.

Viral agents are multitudinous, causing equine infectious anemia, pig cholera, fowl pox, rabies, canine distemper and a host of other diseases. Several viral agents cause tumour formation in poultry, known as the leukosis complex, resulting in serious economic loss. Influenza viruses cause serious problems in pigs, horses, and birds.

Some viruses spread from mother to offspring through the placenta or through the egg (vertical transmission) and some have very resistant forms that can survive in dust. Other viruses require intimate contact to be contagious. Still others are spread by the bite of arthropods.

Viruses are not always limited to one species of animals or to one kind of tissue or organ. On the other hand, the severity of some diseases may be much greater in one species or one kind of tissue.
Virus structure and classification

A major branch of virology is virus classification. Viruses can be classified according to the host cell they infect, animal viruses, infecting bacteria, which include the most complex viruses). Another classification uses the geometrical shape of their capsid (often a helix or an icosahedron) or the virus's structure (e.g. presence or absence of a lipid envelope). Viruses range in size from about 30 nm to about 450 nm, which means that most of them cannot be seen with light microscopes. The shape and structure of viruses can be studied with electron microscopy, with NMR spectroscopy, and most importantly with X-ray crystallography.

The most useful and widely used classification system distinguishes viruses according to the type of nucleic acid they use as genetic material and the viral replication method they employ to coax host cells into producing more viruses

- DNA viruses (divided into double-stranded DNA viruses and the much less common single-stranded DNA viruses),

- RNA viruses (divided into positive-sense single-stranded RNA viruses, negative-sense single-stranded RNA viruses and the much less common double-stranded RNA viruses),

- Reverse transcribing viruses (double-stranded reverse-transcribing DNA viruses and viruses including retroviruses).
The latest report by the International Committee on Taxonomy of Viruses (2005) lists 5450 viruses, organized in over 2,000 species, 287 genera, 73 families and 3 orders.

2.2.3 Fungal diseases

Fungi occur widespread in the environment (soil, air and water) and include mould on stale food and mushrooms. Fungi need to grow on organic material in order to feed, and this can include animal and human. An example of a fungal disease in animal is ringworm. Some fungi are normally harmless, but can cause disease in some situations, especially after prolonged use of antibiotics. Some fungi can also produce toxins or poisons which can be a problem when food becomes stale or wet. Fungi cause many serious diseases of animal. Aspergillus fungi may cause necrosis of the lungs, the nervous system, and other organs. Dermatophytic fungi affect the skin of animals and human. Dust-borne fungi, such as Coccidioides immitis and Histoplasma capsulatum, produce lung disease or generalized disease in animal and human.

2.2.4 Parasitic disease

Parasites are organisms that have to live on or in other organisms, such as animals, in order to survive. Most parasites are easy to see, although some mites and the early stages of worms can only be seen under a microscope.
External parasites

Flies, lice, fleas, ticks and mites can cause serious diseases in animal. Some live on the animal for their entire lives, others only spend part of their lives there, while others only visit to feed. They can result in irritation and skin damage in animal. Some parasites can also pass diseases such as red water and three-day stiff sickness between animal.

Internal Parasites

Internal parasites (including roundworms, flukes and tapeworms) can cause serious diseases and loss of production in animals. They usually live in the stomach and intestines but also in other parts of the body such as the lungs and liver.

Parasites, which attack all animal, range in size from tiny protozoa to metre-long kidney worms.

2.2.5 Hereditary disease

Heredity plays a large part in animal disease, either in directly causing skeletal, skin, or endocrine defects, or by making the animal more susceptible to other disease agents.
2.3 Environmental factors

Environmental problems, such as littering, contribute to some diseases, for example, animals may eat plastic bags or wires and this can harm the animal’s health. Heat is an important factor environmentally, especially in young animals whose protective coats or physiological mechanisms have not yet developed. Chilling or overheating can cause death, and male sterility may develop from relatively slight overheating. Electricity, in the form of lightning or of feed-intake-inhibiting shocks from mechanical feeders, is always a hazard to animals. High-frequency radiation may also cause serious trouble. Poisonous plants may cause serious losses. Drugs used excessively or improperly kill many animals. Water is essential for most of the body functions. Lack of water causes death. Overeating, especially of unusual feeds, causes digestive disorders.

2.4 Control of disease

Control measures in present-day programmes include cooperation of agencies in the study and control of animal diseases; inspection of red meat and poultry to minimize the danger of spread of animal disease to human being; inspection and evaluation of vaccines and other pharmaceutical and biological products as to purity, efficacy, and safety; and in extreme cases, as with outbreaks of foot-and-mouth disease, the mass slaughter of animal and the destruction of carcasses. Universities and other research institutions conduct studies on the disease problems that affect animal of all kinds.
References


15. Todar’s online book of Bacteriology, Kenneth Todar, Ph.D., University of Wisconsin, Department of Bacteriology.