UNIT 9 FOOD BORN DISEASES

Structure

9.0 OBJECTIVES

After reading this unit, you will be able to:

- know the food borne diseases;
- learn to differentiate between food borne intoxications and food borne infections;
- explain that the food borne diseases may be caused due to microorganisms, both bacterial and non bacterial or chemicals;
- explain why investigation of food borne disease outbreak is necessary; and
- describe how the investigation of food borne disease outbreak is carried out.

9.1 INTRODUCTION

Food borne disease (FBD) is caused by consuming contaminated foods or beverages. In addition poisonous chemicals or other harmful substitutes can cause food borne diseases if they are present in food. More than 250 different food borne diseases have been described. A classification of food borne diseases is given in Figure 9.1. Food borne diseases may be intestinal diseases but can be other type as well.

9.2 TYPES OF FOOD BORN DISEASES

With regard to their epidemiology, they can be divided into two major categories (Figure 9.2):

i) **Food borne Intoxication:** Examples include botulism or staphylococcal food poisoning, the causative microorganism produces an exotoxin in food: when a person consumes the food, the toxin is ingested and gives rise to disease.

ii) **Food borne Infections:** the causative organisms are ingested: these subsequently grow within the body and cause damage.

Both infections and intoxications often cause diarrhoea. Severe diarrhoea accompanied by blood or mucus is called dysentery. Both types of digestive system diseases are also frequently accompanied by abdominal cramps, nausea and vomiting. Diarrhoea and vomiting are both defensive mechanisms designed to rid the body of harmful material.

The general term gastroenteritis is applied to disease causing inflammation of the stomach and intestinal mucosa.

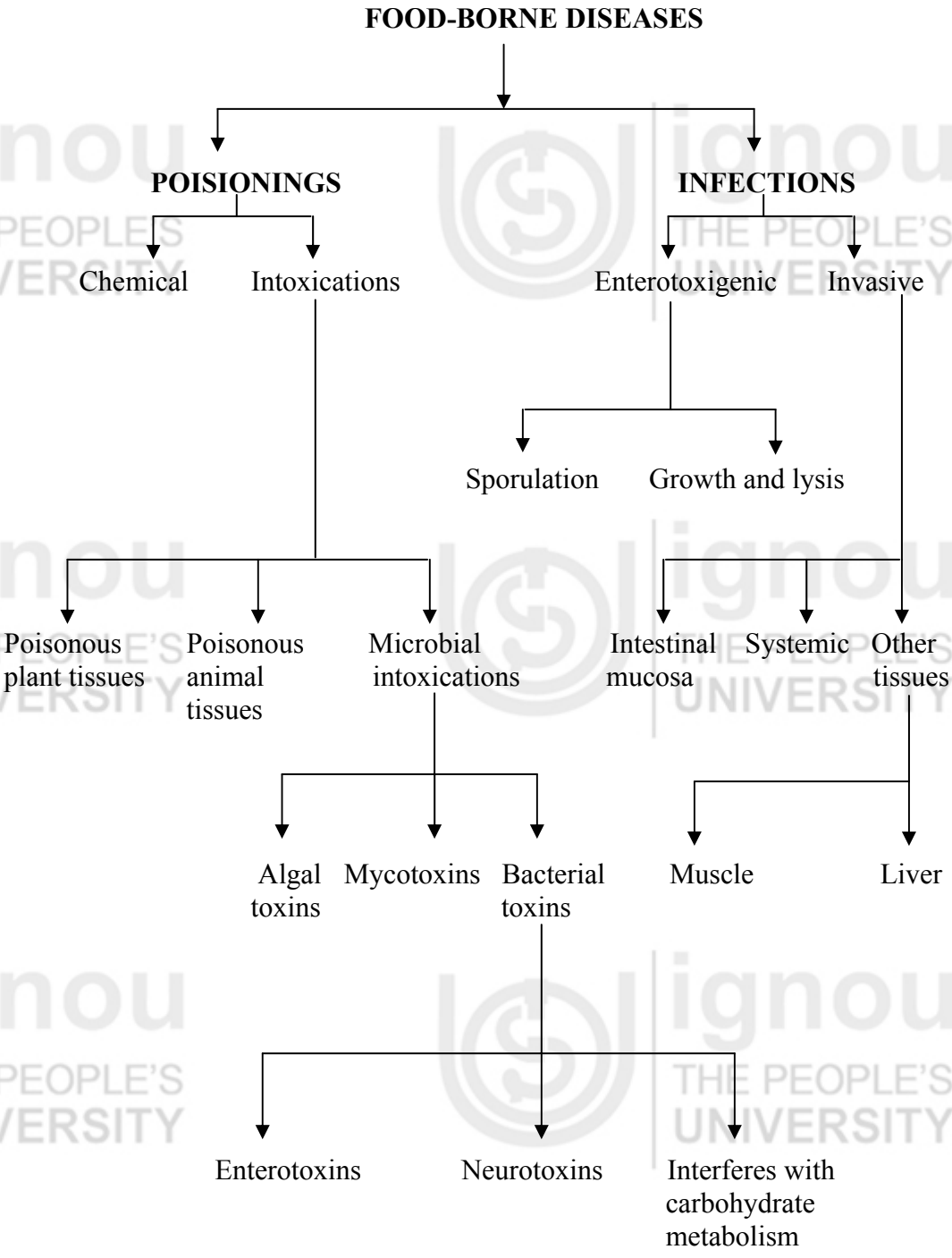

Figure 9.1: Classification of food borne diseases

FOOD-BORNE DISEASES: BACTERIAL

Intoxications	Infections
1. Staphylococcal intoxication (staphyloccocal enterotoxicosis): an enterotoxin produced by *Staphylococcus aureus*	1. Salmonellois: enterotoxin and cytotoxin of *Salmonella* spp.
2. Botulism: a neurotoxin produced by *Clostridium botulinum*	2. *Clostridium perfrigens* illness: an enterotoxin released during sporulation of *Clostridium perfringens* type A in the intestinal tract
	3. *Bacillus cereus* gastroenteritis: an exo-enterotoxin released during lysis of *Bacillus cereus* in the intestinal tract
	4. *Enteropathogenic Escherichia coli* infection: Several serotypes of *E. coli,* some invasive and some enterotoxigenic
	5. *Others:* Yersiniosis, Shigellosis *Vibrio parahaemolyticus*

Figure 9.2: Bacteria responsible for food borne intoxications and infections

9.3 HUMAN DISEASES

Microorganisms that produce infectious diseases in human are categorized as pathogens, because they have the ability to injure body tissues and/or alter body functions.

In general, pathogenic microorganisms express their disease-producing properties through two kinds of mechanisms: (1) invasion of tissues (invasive microorganisms) and (2) production of toxins (toxigenic microorganisms).

Invasive pathogens have the ability to produce and excrete one or more kinds of extracellular enzymes resulting in injury to host tissues. Toxigenic microorganisms produce toxins of two types:

- Exotoxins – produced within certain kinds of bacteria and excreted into their surrounding environment. They are proteins in chemical composition and are relatively specific in terms of damage to the host.
- Endotoxins – are complex polysaccharides cell wall components of certain kind of bacteria. They are not released until the cell disintegrates. They are relatively heat stable, less specific in their actions and less potent than exotoxins.

The severity and distribution of any infectious disease are influenced by the manner in which the agent, the host and factors within the environment interact.

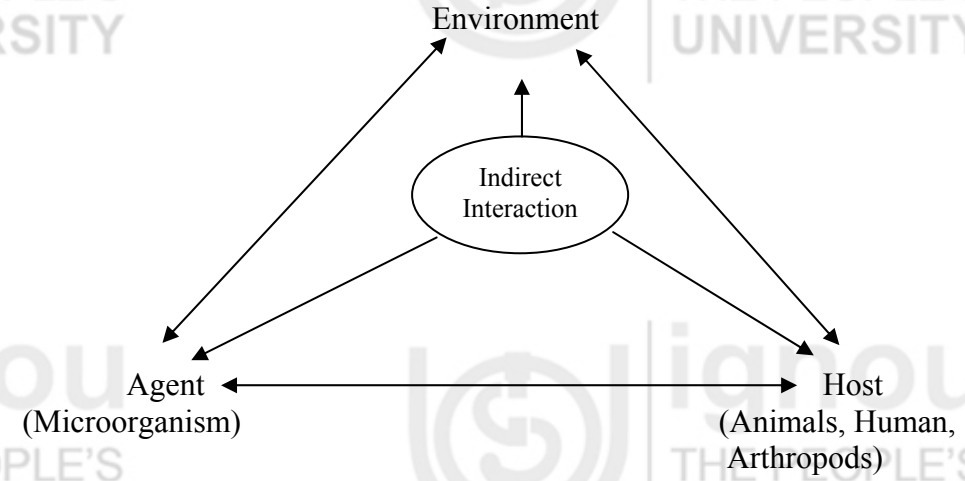

Figure 9.3: Generalized version of the triangle of causation for any kind of communicable disease

The main causes of reported food borne diseases are due to foods being mishandled. Foods that are implicated are usually "potentially hazardous" which are capable of supportive growth of disease-causing microorganisms. The various factors leading to FBD are listed in Table.

Table 9.1: Factors leading to reported food borne diseases (Ranked by % number of outbreaks)

40%	Improper cooling of foods
21%	Time lapse between preparing to serving
20%	Infected persons touching foods
16%	Inadequate cooling
16%	Improper hot storage
12%	Inadequate reheating
11%	Contaminated raw food
7%	Cross-contamination
7%	Improper cleaning
4%	Use of leftovers

9.4 CHEMICAL CONTAMINANTS OF FOOD

Poisoning by consumption of chemicals is rather uncommon and usually is characterized by appearance of the symptoms within a short period of time after the poisonous food is eaten. Various chemical contaminants include:

i) Fumigants are used to sterilize food under conditions in which steam heating is impractical. Ethylene oxide is a commonly used fumigant, which reacts with food constituents and destroys essential nutrients. It reacts with inorganic chloride to form ethylene chloro hydrine, which is toxic.

ii) Various solvents are used for the extraction of oil from oilseeds. But solvents like trichloro ethylene react with the foodstuff being processed with the formation of toxic products.

iii) Smoking of meat and fish for preservation and flavouring is an old practice. This processing contaminates the food with polycyclic hydrocarbons such as benzopyrene, many of which are carcinogenic.

iv) Metals are one of the many unintentional contaminants of food. When present beyond small quantities they are toxic. They find their way into food through air, water, soil, industrial pollution and other routes. Antimony, arsenic, cadmium, chlorinated hydrocarbons, copper, cyanide, fluoride, lead, selenium, mercury and zinc in foods have been blamed for food poisoning. Poisonous chemicals may enter foods from utensils e.g. from cheap enamelled utensils which contain antimony. Lead and arsenic residues from fruit sprays maybe on the surface of fruits but usually in harmless amounts, especially after washing. Symptoms of lead poisoning include weakness, dental caries, nausea, pains and paralysis. A major source of tin contamination is tin plate, which is used for containers of all types of processed foods. Canned foods if acidic and foods stored in tins after opening, change in colour, or develop a metallic flavour that is unacceptable. Insecticides, pesticides, growth regulators, fungicides and growth stimulators are essential in modern agriculture for the production of adequate quantities of sound food. They include insecticides like lead arsenate, organophosphate compounds (malathion), dinitro compounds. Toxicity levels for human vary.

Check Your Progress Exercise 1

Note: a) Use the space below for your answer.
b) Compare your answers with those given at the end of the unit.

1. What are food borne diseases?

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2. Differentiate between exotoxins and endotoxins.

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3. List the various chemical contaminants in food.

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Table 9.2: Toxicity of some metals in different foods

Metal	Type of Food	Toxic Effect
Arsenic	Fruits sprayed with lead arsenate	Dizziness, chills, cramps, paralysis leading to death
Barium	Foods contaminated with rat poison (barium carbonate)	Violet peristalsis, muscular twitching and convulsions
Cadmium	Fruit juice, soft drinks in contact with cadmium plated vessels	Excessive salivation and kidney damage, prostrate cancer, multiple fractures
Cobalt	Water, beer	Cardiac failure
Copper	Acid foods in contact with tarnished copper ware and brass utensils	Vomiting, diarrhea, abdominal pain
Lead	Processed foods	Paralysis, brain damage
Mercury	Mercury fungicide treated seed grains or mercury contaminated fish	Paralysis, brain damage and blindness
Tin	Canned foods	Colic, vomiting. Photophobia
Zinc	Foods stored in galvanized iron ware	Dizziness, vomiting

Table 9.3: Toxicity in food due to various pesticides and chemicals

Name of Pesticide	Type of Food	Toxic Effect
Pesticides	All type of raw, cooked, processed, canned foods	Acute or chronic poisoning causing damage to liver, kidney, brain, nerves leading to death
Diethylstil bestrol	Meat of still bestrol fed animals	Teratogenesis, carcinogenesis
Antibiotics	Meat of animals fed antibiotics	Drug resistance, hardening of arteries, heart diseases

Table 9.4: Permissible limits of some metals in foods

Name of metal	Foodstuff	PPM
Arsenic	1. Milk	0.10
	2. Beverages	0.50
	3. Soft Drinks	0.50
	4. Ice creams and frozen confections	0.50
	5. Dehydrated onions	2.0
	6. Dried spices and herbs	5.0
Copper	1. Beverages, soft drinks	7.0
	2. Tomato ketchup	50.0
	3. Cocoa powder	70.0
	4. Tomato puree, paste, juice powder	100.0
	5. Sugar confectionary	5.0
Lead	1. Beverages and soft drinks	0.50
	2. Fruits and vegetable juices	1.0
	3. Ice cream, frozen confections, canned fish, meat, dehydrated vegetables	1.0
Tin	1. Processed and canned foods	5.0
	2. Hard boiled sugar confectionary	5.0
Zinc	1. Beverages	5.0
	2. Fruit products	50.0
	3. Hard boiled sugar confectionary	5.0

9.5 NON-BACTERIAL MICROBIOLOGICAL CONTAMINATION OF FOOD

Microbiological contamination of food may include food borne illness due to bacteria or non bacterial sources such as mycotoxins, viruses, rickettsias, parasitic worms or protozoa or from the consumption of food contaminated with toxic substances. The food borne infections caused by bacteria will be dealt with in Unit 3 in detail.

9.5.1 Viruses

Much less is known about the incidence of viruses in foods than about bacteria and fungi because they do not grow in culture media as do bacteria and fungi, they do not replicate in foods thus found in low numbers. It is noted that virtually any food can serve as a vehicle for virus transmission. The most common food source of gastroenteritis causing virus is shellfish.

Hepatitis A virus

There are more documented outbreaks of hepatitis A traced to foods than any other viral infection. The virus causes hepatitis (jaundice) and leads to inflammation of liver. The incubation period for infectious hepatitis ranges from 15 to 45 days and lifetime immunity usually occurs after an attack. The fecal-oral route is the mode of transmission, and raw or partially cooked shellfish from polluted waters is the most common vehicle food. Shellfish are able to concentrate the numbers of bacteria or viruses during their normal feeding, which is to filter and remove particles from the water. The infectious hepatitis virus has been shown to be stable during refrigerated storage of shellfish. In addition to shellfish, raw milk, potato salad, sandwiches and cold meat cuts are also probable sources of the virus. Symptoms of jaundice include loss of appetite, yellowing of eyes, nails and skin (due to presence of bile pigments) and gastrointestinal disorder. Proper cooking, hygiene, sanitation and personnel cleanliness help to prevent virus attack.

Polio Virus

There are a large number of reported food-borne outbreaks of polio in India. It is most common in children up to 5 years. Milk is the most probable food there causes spread of polio virus. The virus reproduces in the intestinal tract, from there it invades the motor cells of the central nervous system. Initial symptoms are gastrointestinal, headache, muscle pain and paralysis. The paralytic symptoms range from sub clinical to fatal. Preventive measures include immunization of children, proper processing (pasteurization) of milk, hygienic conditions and use of potable water.

Norwalk Virus and Norwalk-like Viruses

These viruses, also known as small round structured viruses or caliciviruses, are an important cause of gastrointestinal illness throughout the United States. Members of this category of viruses are typically named for the location in which they were first identified, for example, Hawaii, Snow Mountain, Montgomery County and Oklahoma. The Norwalk virus is the prototype for this group of viruses – there are at least 11 other related viruses – hence the name "Norwalk-like virus."

Symptoms: The signs and symptoms of Norwalk-like viruses include nausea, vomiting, diarrhea, abdominal pain, muscle aches, headache, tiredness and low-grade fever. Symptoms typically last 24 hours to 48 hours and subside on their own. There are no known long-term effects after recovery from this infection.

Transmission of viruses: Humans are the only source for these viruses. These viruses do not multiply outside the human body. The viruses are present in the feces of infected persons and can be transmitted to others when hands are not thoroughly washed after having a bowel movement.

9.5.2 Rickettsias

Rickettsias maybe considered as degenerative bacteria since they represent a form of life closely resembling bacteria except that they cannot be cultivated outside of living cells. Like the viruses they are obligate parasites. Many of the major human rickettsial diseases are by bites from fleas, lice or ticks. Examples of human rickettsial diseases include epidemic typhus, rickettsial

pox, Rocky mountain spotted fever and Q fever. Cows infected with rickettsia of Q fever, *Coxiella brunettii* excrete contaminated milk which result in human infections. Hence milk is pasteurized at a minimum temperature of 62.8ºC for 30 minutes to ensure its destruction.

9.5.3 Food Borne Parasites

Trichinosis

Trichinella spiralis causes trichinosis, which results from the consumption of raw or incompletely cooked pork containing the encysted larvae.

Symptoms: One or two days after ingestion of heavily encysted meat, trichinae penetrate the intestinal mucosa, producing nausea, abdominal pain, diarrhea and sometimes vomiting. The symptoms may persist for several days. The larvae then attack the skeletal muscles, muscle pain (paralysis) is the universal symptom accompanied in difficulty in breathing, chewing and swallowing. After six months of initial infection, pain, swelling and fever occur.

Prevention and control: Chief method for prevention of trichinosis is the treatment of pork (or other meat) to ensure the destruction of any trichinae that maybe present by cooking of pork till at least 58.3ºC, quick freezing or storage at -15ºC or lower for not less than 20 days, irradiating or processing of sausage and similar meat products properly by salting, drying, smoking and refrigeration. Also trichinosis can be controlled by avoiding feeding of infected meat scraps to swine and by preventing the consumption of infested tissue by other animals.

Amoebiasis

Entamoeba histolytica is a single celled parasitic animal – a protozoa, that infects predominantly humans and other primates and causes amoebiasis. Diverse mammals such as dogs and cats can become infected but usually do not shed cysts (the environmental survival form of the organism) with their feces, thus do not contribute significantly to transmission. The active (trophozoite) stage exists only in the host and in fresh feces; cysts survive outside the host in water and soil and on foods, especially under moist conditions on the latter. When swallowed they cause infections by excysting (to the trophozoite stage) in the digestive tract (amoebiasis).

Symptoms: Infections that sometimes last for years may be accompanied by 1) no symptoms, 2) vague gastrointestinal distress, 3) dysentery (with blood and mucus). Most infections occur in the digestive tract but other tissues may be invaded. Complications include 4) ulcerative and abscess pain and, rarely, 5) intestinal blockage. Onset time is highly variable. It is theorized that the absence of symptoms or their intensity varies with such factors as 1) strain of amoeba, 2) immune health of the host, and 3) associated bacteria and, perhaps, viruses. The amoeba's enzymes help it to penetrate and digest human tissues; it secretes toxic substances.

Diagnosis: The ingestion of one viable cyst can cause an infection. Human cases are diagnosed by finding cysts shed with the stool; various flotation or sedimentation procedures have been developed to recover the cysts from fecal matter; stains (including fluorescent antibody) help to visualize the isolated cysts for microscopic examination. Since cysts are not shed constantly, a

minimum of 3 stools should be examined. In heavy infections, the motile form (the trophozoite) can be seen in fresh feces. Serological tests exist for long-term infections. It is important to distinguish the *E. histolytica* cyst from the cysts of nonpathogenic intestinal protozoa by its appearance.

Transmission: Amebiasis is transmitted by fecal contamination of drinking water and foods, but also by direct contact with dirty hands or objects as well as by sexual contact.

Giardiasis

Giardia lamblia (intestinalis) is a single celled animal, i.e., a protozoa, that moves with the aid of five flagella. Organisms that appear identical to those that cause human illness have been isolated from domestic animals (dogs and cats) and wild animals (beavers and bears). A related but morphologically distinct organism infects rodents, although rodents may be infected with human isolates in the laboratory. Human giardiasis may involve diarrhea within 1 week of ingestion of the cyst, which is the environmental survival form and infective stage of the organism.

Symptoms: Normally illness lasts for 1 to 2 weeks, but there are cases of chronic infections lasting months to years. Chronic cases, both those with defined immune deficiencies and those without, are difficult to treat. The disease mechanism is unknown, with some investigators reporting that the organism produces a toxin while others are unable to confirm its existence. The organism has been demonstrated inside host cells in the duodenum, but most investigators think this is such an infrequent occurrence that it is not responsible for disease symptoms. Mechanical obstruction of the absorptive surface of the intestine has been proposed as a possible pathogenic mechanism, as has a synergistic relationship with some of the intestinal flora.

Diagnosis: *Giardia lamblia* is frequently diagnosed by visualizing the organism, either the trophozoite (active reproducing form) or the cyst (the resting stage that is resistant to adverse environmental conditions) in stained preparations or unstained wet mounts with the aid of a microscope. A commercial fluorescent antibody kit is available to stain the organism. Organisms may be concentrated by sedimentation or flotation; however, these procedures reduce the number of recognizable organisms in the sample.

Associated foods: Giardiasis is most frequently associated with the consumption of contaminated water. Outbreaks have been traced to food contamination by infected or infested food handlers, and the possibility of infections from contaminated vegetables that are eaten raw cannot be excluded. Cool moist conditions favor the survival of the organism.

Prevalence: Giardiasis is more prevalent in children than in adults, possibly because many individuals seem to have a lasting immunity after infection. This organism is implicated in 25% of the cases of gastrointestinal disease and may be present asymptomatically. This disease afflicts many homosexual men, both HIV-positive and HIV-negative individuals. This is presumed to be due to sexual transmission. The disease is also common in child day care centers, especially those in which diapering is done.

Ascariasis

Humans worldwide are infected with *Ascaris lumbricoides* and *Trichuris trichiura*; the eggs of these roundworms (nematode) which are "sticky" and may be carried to the mouth by hands, other body parts, fomites (inanimate objects), or foods. Ascariasis and trichuriasis are the scientific names of these infections. Ascariasis is also known commonly as the “large roundworm” infection and trichuriasis as “whip worm” infection.

Diagnosis: Infection with one or a few Ascaris sp. may be unapparent unless noticed when passed in the feces, or, on occasion, crawling up into the throat and trying to exit through the mouth or nose. Infection with numerous worms may result in a pneumonitis in the lungs, where the larvae break out of the pulmonary capillaries into the air sacs, ascend into the throat and descend to the small intestine again where they grow, becoming as large as 31 × 4 cm. Vague digestive tract discomfort sometimes accompanies the intestinal infection, but in small children with more than a few worms there may be intestinal blockage because of the worms' large size. Not all larval or adult worms stay on the path that is optimal for their development; those that wander may locate in diverse sites throughout the body and cause complications. Both infections are diagnosed by finding the typical eggs in the patient's feces; on occasion the larval or adult worms are found in the feces or, especially for *Ascaris* sp., in the throat, mouth, or nose.

Associated foods: The eggs of these worms are found in insufficiently treated sewage-fertilizer and in soils where they embryonate (i.e., larvae develop in fertilized eggs). The eggs may contaminate crops grown in soil or fertilized with sewage that has received nonlethal treatment; humans are infected when such produce is consumed raw. Infected food handlers may contaminate a wide variety of foods.

Prevention: Both infections may self-cure after the larvae have matured into adults or may require anthelmintic treatment. In severe cases, surgical removal may be necessary. Allergic symptoms (especially but not exclusively of the asthmatic sort) are common in long-lasting infections or upon reinfection in ascariasis.

Check Your Progress Exercise 2

Note: a) Use the space below for your answer.
b) Compare your answers with those given at the end of the unit.

1. What are the non-bacterial food borne disease causing agents?

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2. What is the causative organism for jaundice and how is it transmitted?

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3. List the food-borne parasites. What are the symptoms of the disease cause by them?

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9.6 INVESTIGATION OF FOOD BORNE DISEASE OUTBREAK

Analysis of an outbreak involves field analysis as well as laboratory analysis and is undertaken by Ministry of Health. From public health point of view the objectives of the investigation of outbreak are:

1. *Prevention and control*

   Identification of contaminated foods

2. *Knowledge of disease causation*

   Observe the track record of various illnesses-causing agents

3. *Administration guidance*

   Assessment of trends to justify regulations, decisions/actions

This requires the location and the identification of the causative agent, establishing of the means of transmission, demonstration of opportunity for growth of the pathogen.

Personnel Involved in Investigation

The team to investigate an outbreak of food borne disease consists of a person in charge, a field group and a laboratory group. The field group interviews persons, both ill and healthy, who consumed the suspected foods, physicians and nurses who are treating the victims, and personnel at the place of exposure to the disease; collects samples of suspected foods and transits them to the laboratory, collects specimens from patients or food handlers when such sample is indicated; inspects the premises where the foods were stored,

prepared and served; fills out appropriate reports on these activities, and makes it available for laboratory staff. The laboratory group makes microbiological and chemical tests as indicated by reports of the field group and the nature of the suspected food and records its findings on appropriate report blanks. The person in-charge or a qualified epidemiologist then can interpret the data from all sources to determine the cause and source of disease outbreak.

Steps of Investigation

Field Analysis

a) Gathering information

The field group inspects the place or places where the suspected meal, meals or beverages were prepared and consumed and then record the results in appropriate forms. Information sought includes the menu for meals, source and method of preparation of each item on the menu, methods of storage of perishable foods, health of employees serving or preparing foods and their health history. The information obtained is recorded on a form entitled "Case History Questionnaire" as given.

Performa

Name of Person affected	Age	Time of First Symptom	Foods Consumed

The Performa indicate the most likely age group affected and the type of food being consumed by them. Also we get an idea of the type of food through which the infection could have probably been caused.

b) Sample collection

Samples of left over food and /or beverage served at suspected meal are aseptically collected by means of sterile sampling devices in sterile containers, labelled and transited to laboratory under refrigerated conditions.

c) Collection of specimens from human sources

Specimens maybe obtained from patients with food illnesses or from food handlers to ascertain the ultimate source of the pathogen that entered the food. Culture from nose, throat or skin lesions, fecal or blood samples may be done.

Laboratory Analysis

The sample received from the field are analyzed microbiologically and sometimes for chemical contamination also. The report is then sent to the in-charge, the epidemiologist (who is expert in dealing with epidemics).

Performa for Laboratory Report

Etiological Agent (Causative Agent of Spoilage)	Clinical Symptoms (of affected people)	Laboratory Investigation	Complete Investigation (Food responsible for Outbreak)	Preventive Measures
Eg: For *Bacillus gastroenteritis*		Investigation of food, stools and faeces. Isolation of the microorganism	Infection due to accidental contamination or otherwise	Asepsis, prevent inadequate treatments, proper storage conditions

Interpretation of Report

This is done by the epidemiologist and conclusion is taken out for cause of the outbreak. Complete investigation of food borne disease outbreak is given as:

i) Name of the reporting officer

ii) Name of the local authority who is analyzing the complete outbreak

iii) Area/place of outbreak

iv) Date and time when suspected meal was taken

v) Number of persons' affected

vi) Number of people at risk indicating those who have developed symptoms)

vii) Incubation Period

viii) Symptoms

ix) Occupational/age group

x) Details of suspected meal (complete analysis of food)

xi) Foods which are eaten by affected persons

xii) Number of meal sittings and time

xiii) Methods of cooking

xiv) Time and temperature of storage of cooking

xv) General notes regarding the facilities and equipments

Minimum Infrastructure/ Materials Required

- Field Kit for field analysts to collect sample, medical equipment, sterile containers, sampling device, sterilized thermometer, lamps of alcohol, sterile wrapping foil, tapes for sealing, sterile paper, towels, ice boxes, insulated boxes for carrying samples.
- Laboratory- Facility to find the total plate count and types of microorganisms, glassware, pipettes, flask, media, laminar flow, stains. Chemicals, specific test kits for enumerating specific organisms.
- Data interpretation infrastructure.

WHO'S Golden Rule for Safe Food Production

1. Choose foods processed for safety.
2. Cook foods thoroughly.

3. Eat cooked foods immediately.
4. Store cooked foods carefully.
5. Reheat cooked foods thoroughly.
6. Avoid contact between raw and cooked foods.
7. Wash hands repeatedly.
8. Keep all kitchen surfaces meticulously clean.
9. Protect foods from insects, rodents and other animals.
10. Use pure water.

Check Your Progress Exercise 3

Note: a) Use the space below for your answer.
b) Compare your answers with those given at the end of the unit.

1. What are the main objectives for which investigation of any outbreak is done?

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2. Explain the various steps involved to carry out any investigation.

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3. State WHO's Golden rule for safe food production.

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9.7 LET US SUM UP

In this unit on food borne disease, we have examined what are the food borne disease and how to differentiate with food borne infections and intoxications. This includes study of various contaminants of food, namely, bacterial, non bacterial and toxic chemicals. We have also studied the importance of the investigation of food borne disease outbreak. The steps involved in the investigation were also studied. We have seen that food borne diseases maybe caused due to contaminated food and beverages. They are a common, distressing and sometimes life-threatening problem for millions of people all around the world. We also studied in the end the related golden rules for the prevention of such food borne disease outbreaks. Hence following good manufacturing practices (GMP's) and giving publicity to an outbreak and the explanation of its cause maybe helpful in educating and warning the public and avoiding further outbreaks.

9.8 KEY WORDS

Food Borne Disease : Disease caused by the consumption of contaminated foods or beverages

Food Borne Intoxication : Food borne disease caused due to ingestion of toxin already present in food.

Food Borne Infection : Food borne disease caused due to ingestion of causative organisms into the body where they multiply, grow and cause disease.

Exotoxin : Proteinaceous toxin produced by bacteria and excreted into surrounding environment

Endotoxin : Toxin produced by bacteria and excreted into surrounding environment after the cell lysis. Are mainly composed of polysaccharides.

9.9 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress Exercise 1

1. Food borne diseases are caused by consuming contaminated foods or beverages e.g., food borne infection and food borne intoxication.
2. Exotoxins are proteinaceous toxins produced by bacteria and excreted into surrounding environment.

   Endotoxins are toxins produced by bacteria and excreted into surrounding environment after the cell lysis (breaking of cell membrane), which are mainly composed of polysaccharides.

3. Chemical contaminants in food include fumigants, solvents like hexane, metallic contaminants such as antimony, arsenic, cadmium etc., insecticides, pesticides and growth regulators etc.

Check Your Progress Exercise 2

1. Non-bacterial food borne disease causing agents include viruses, rickettsias and parasites (*Trichinella, Entamoeba, Giardia, Ascaris*)

2. Jaundice is caused by Hepatitis A virus. through faecal-oral transmission. Foods associated are raw or partially cooked shellfish, raw milk, potato sandwiches and cold meat cuts.

3. Food borne parasites include:

   a) *Trichinells spiralis* (causes Trichinosis) characterized by nausea, abdominal pain, diarrhea and vomiting. Severe attack may cause paralysis, fever and severe pain.

   b) *Entamoeba histolytica* (causes amoebiasis) results in gastrointestinal distress, dysentery, ulcers and intestinal blockage.

   c) *Giardia lamblia* (causes giardiasis) results in severe gastroenteritis and intestinal problems.

   d) *Ascaris lumbricoides* causes ascariasis, resulting in digestive tract disturbance, intestinal disorder and blockage.

Check Your Progress Exercise 3

1. Objectives of food borne disease outbreak investigation are:

   - To prevent and control contamination of foods.
   - To know the disease causing agents.
   - To develop guidelines and take regulatory decisions.

2. Three steps in the investigation of any food borne disease outbreak:

   - **Field Analysis:** Collection of samples and data pertaining to the causes of outbreak in the particular area.

   - **Laboratory Analysis** dealing with the isolation of the causative organism from the various collected samples.

   - **Identification and the Interpretation of Report** involving the compilation of all facts and figures and stating the cause of outbreak and the possible causative measures to be taken.

3. WHO's Golden rule for safe food production states that:

   - Choose foods processed for safety
   - Cook foods thoroughly
   - Eat cooked foods immediately
   - Store cooked foods carefully
   - Reheat cooked foods thoroughly
   - Avoid contact between raw and cooked foods
   - Wash hands repeatedly
   - Keep all kitchen surfaces meticulously clean
   - Protect foods from insects, rodents and other animals
   - Use pure water

9.10 SOME USEFUL BOOKS

1. A manual entitled 'Procedures to Investigate Food borne Illnesses' (1976) has been written by the Committee on communicable Diseases Affecting Man in the International Association of Milk, Food and Environmental Sanitarians and provides excellent information on such food borne diseases and their outbreaks. A complete listing of diseases transmitted by foods, including etiologic agents, nature of the organism, incubation period, signs and symptoms, source or reservoir, epidemiology, foods involved and control measures can be found in Center for Disease Control (1976a).

2. Frazier, W.C. and Westoff, D.C. (1988) Food Microbiology, Tata McGraw-Hill Pub. Co., New Delhi. pp. 539.

3. Purohit, S.S. (1994) Microbiology-Fundamental and Application. 5th edn. Agro Botanical Publishers, Bikaner, India.

4. Srivastava, R.P. and Kumar, S. (1994) Fruits and Vegetable Preservation, International Book Distribution Co., Lucknow.