



MEDICAL UNIVERSITY – PLEVEN
FACULTY OF MEDICINE

**DEPARTMENT OF INFECTIOUS DISEASE, EPIDEMIOLOGY,
PARASITOLOGY AND TROPICAL MEDICINE**

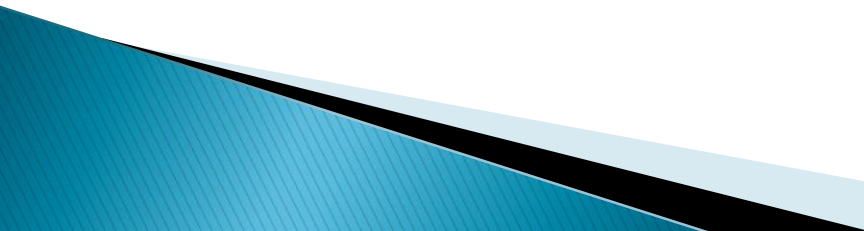
Lecture № 1
SIXTH YEAR MEDICAL STUDENTS -
TRAINEE DOCTORS

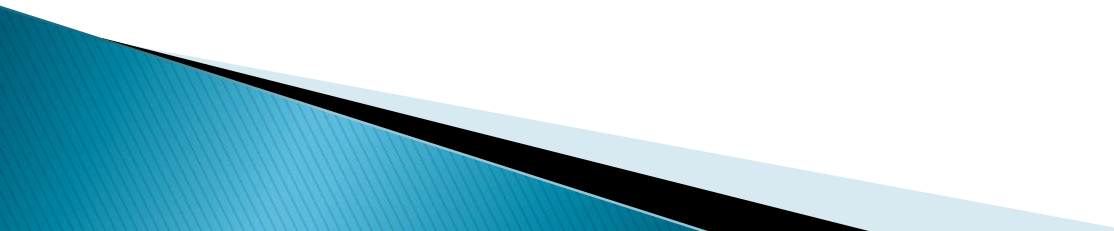
INFECTIOUS DISEASE EPIDEMIOLOGY:
IMPORTANT DEFINITIONS.
CHAIN OF INFECTION.

Assoc. Prof. Dr. M. Karcheva, MD, PhD

Important definitions related to specific concepts

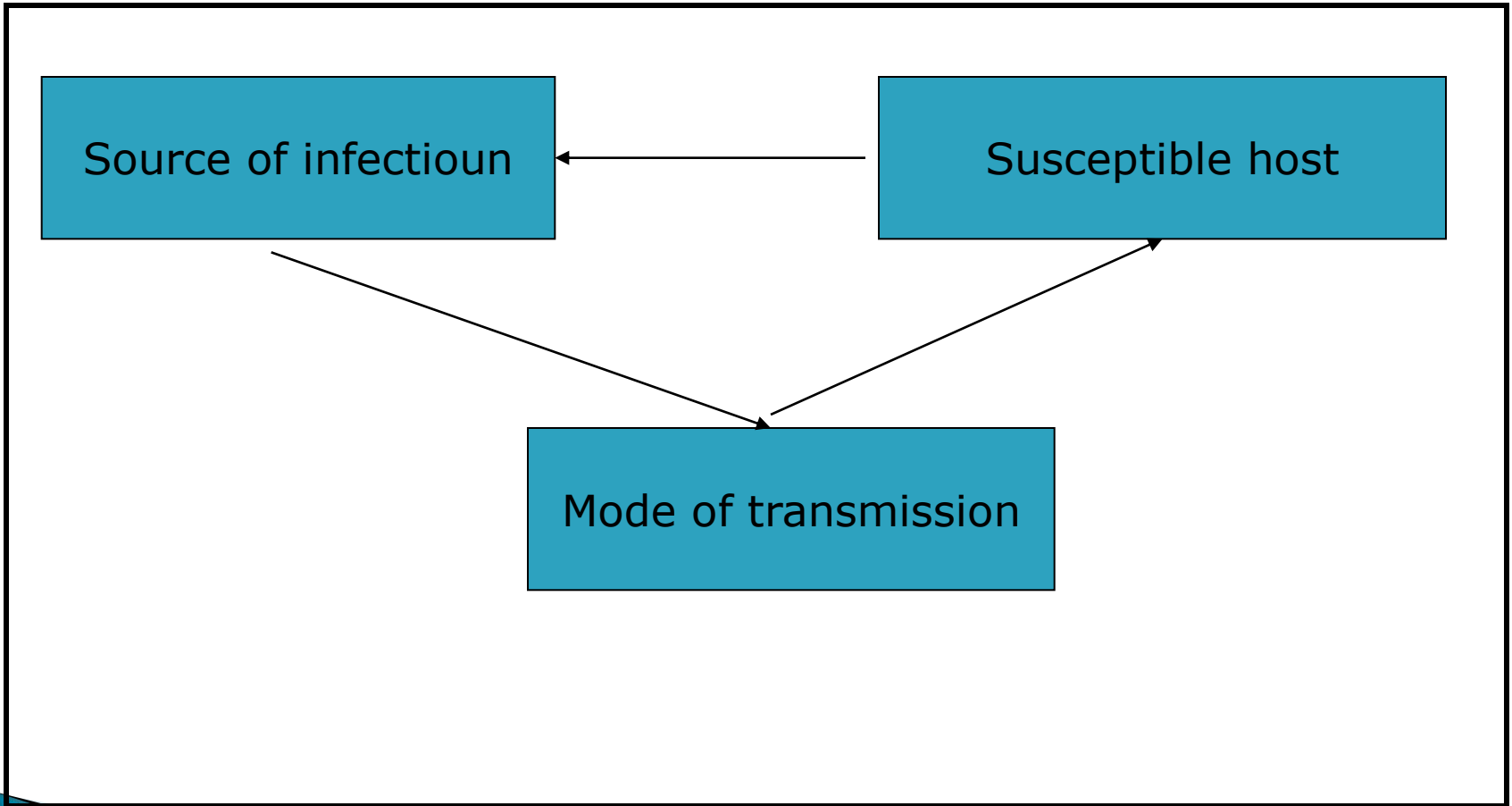
- ▶ Modern epidemiology has been defined as:
“The study of the *distribution* and *determinants* of health-related states or events in specified *population* and *application* of this study to control of health problems” (Last, 1988).

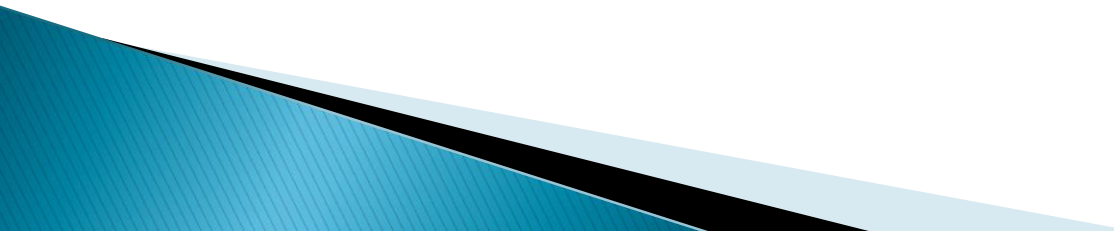
- ▶ In other words: Epidemiology is concerned with:
 - 1/ Describing and explaining the occurrence of disease in populations (*epi = upon/affecting* and *demos = people*);
 - 2/ Development of effective preventive measures (based on the adequate explanation of disease occurrence, by identifying important factors or disease determinants that can be intercepted).
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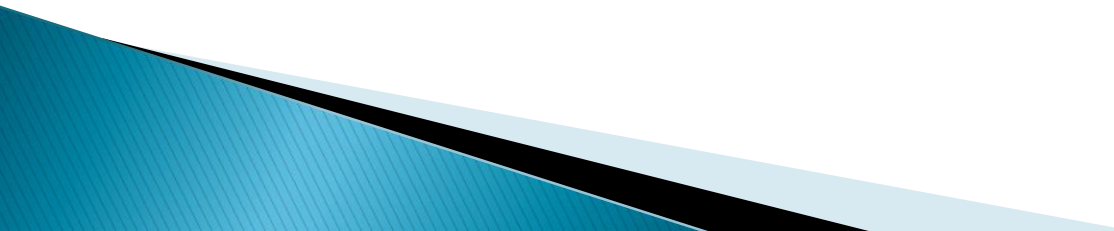
- ▶ Infection disease epidemiology – definition:
“The study of causation and spread of infectious diseases in human populations, and application of this study to control and prevention of infectious diseases with the goal of their eradication” (Definition accepted from the International Conference held in Prague in 1960).
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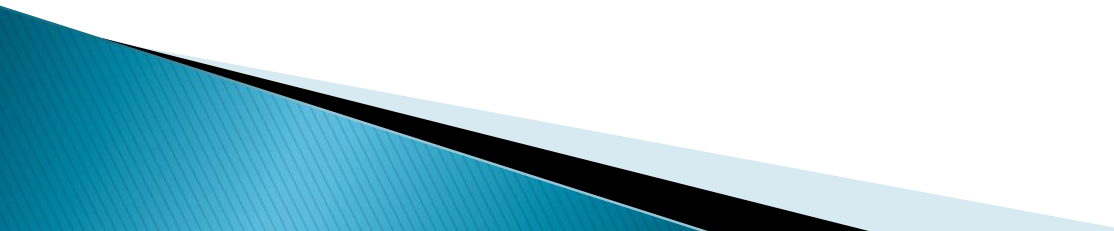
- ▶ Despite some differences in terminology between Western and Russian authors they all define as *a subject of the study* the interaction of the agent, the transmission process and the host, termed “**chain of infection**” (Western version) or “**epidemic process**” (Russian version).

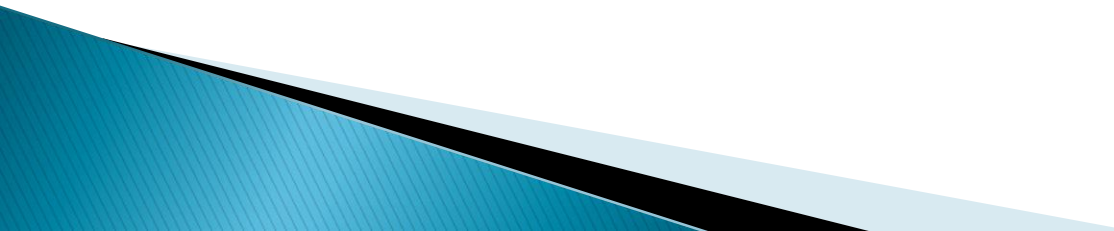
Conditions of Epidemic Process or chain of infection



- ▶ A wide spectrum of biologic and medical disciplines provide means (information and methods) for solution of epidemiological problems.
 - ▶ Clinical medicine, microbiology and biostatistics are the three most important disciplines on which epidemiologic investigation depends.
 - ▶ They have almost universal application in infectious disease epidemiology.
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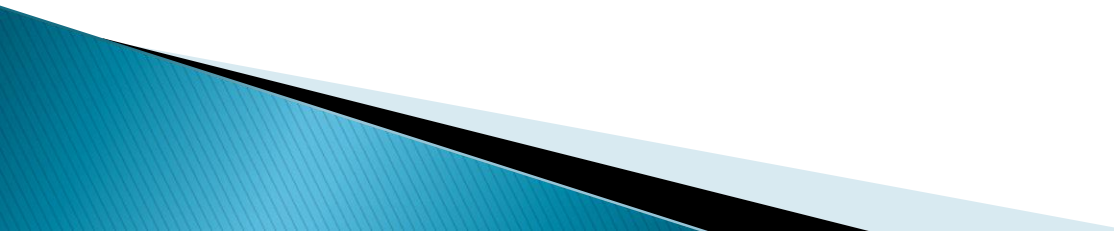
- ▶ Because of the complexity of problems to be studied, epidemiology uses a variety of including the proper epidemiological methodology (descriptive, analytical and experimental studies) and a large number of methods specific for related disciplines (e.g. sero-epidemiology).
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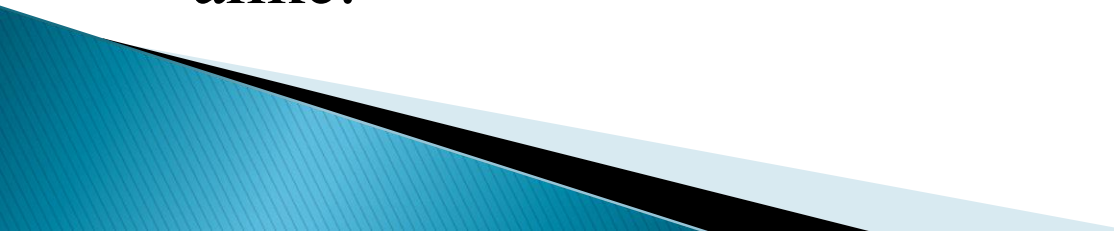
- ▶ Infectious disease epidemiology is a fundamental part of whole of epidemiology.
 - ▶ Moreover, some of the greatest achievements of epidemiology have resulted from the prevention and control of communicable diseases, e.g.
 - ▶ Snow's work on cholera, the smallpox eradication (last case in 1977), and nowadays, the eradication of polio scheduled for 2005.
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- ▶ At present, there is a renaissance in the study of communicable diseases.
 - ▶ The development of e and effective antimicrobial drugs and wide variety of vaccines has led to the cure and prevention of many infectious diseases.
 - ▶ However, it was not followed, as anticipated, by the virtual disappearance of infectious diseases.
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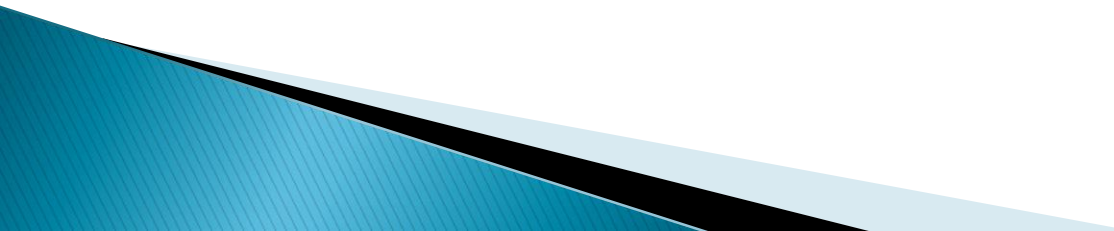
- ▶ They continue to present the most important acute health problems in all countries (developing and industrialized) due to:
- ▶ 1/ Changing and resurgence of some classic infections which were previously well controlled (tuberculosis in the USA since 1985 and subsequently in other industrialized countries; severe diphtheria epidemic in the former Soviet Union in the 1990's; outbreak of plague in Surat, India in 1994; tularemia and Mediterranean spotted fever in Bulgaria in the 1990's).

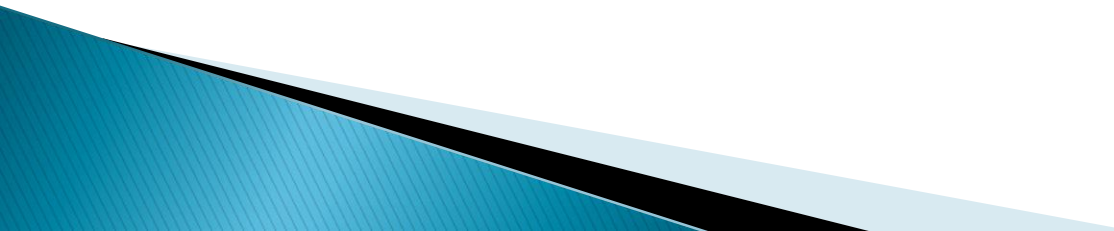
- ▶ 2/ Emergence of new infections (HIV/AIDS considered to be the most devastating of all emerging infectious, responsible for doubling or tripling of tuberculosis cases in some countries; hemorrhagic fevers due to Ebola, Lassa and Marburg viruses, responsible for outbreaks with very high mortality; Legionnaires disease, described after an outbreak of pneumonia in Philadelphia, in 1976).

- ▶ 3/ Development and spread of resistance to antimicrobial drugs (multi-drugs resistant tuberculosis and shigellosis, penicillin-resistant gonorrhoea and pneumococcal infection, methicillin-resistant staphylococcus aureus).
 - ▶ Obviously, the prevention and control of recently observed new and resurgent infections needs a further development of epidemiological knowledge and experience.
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- ▶ Like every self-respecting branch of science, epidemiology has its own words and phrases to describe its concepts, principles, methods and procedures.
 - ▶ The purpose of such terms is not to deter the novice, but rather to lay a foundation for precise communication (the language of the discipline).
 - ▶ The uncontrollable creation of new terms and disagreement about the meaning of old ones can confuse beginners and established epidemiologists alike.
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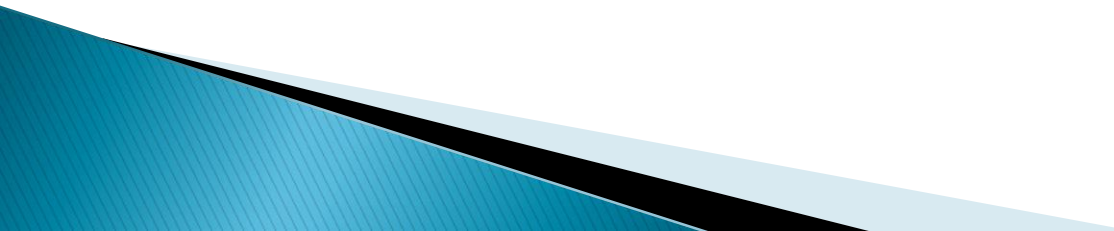
- ▶ Clear- cut definitions of the terms are essential for any kind of epidemiological activity, e.g. disease surveillance, outbreak investigations, analysis of data, and so on.
- ▶ There are a number of definitions that are chiefly or only used in infectious disease epidemiology.
- ▶ The first concerns the subject itself: sometimes a distinction is made between communicable and infectious disease, when the former is a subset of the latter and is taken only to include those diseases that can spread from person to person.

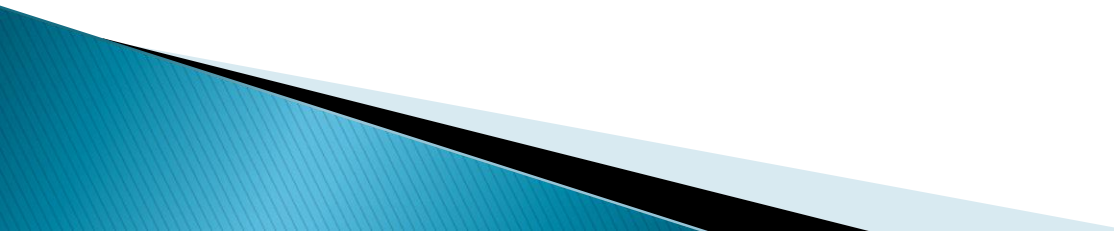
- ▶ **Communicable disease (syn. Infectious disease).**
 - ▶ All illness due to a specific infectious agent or its toxic products that arises through transmission of that agent or its products from an infected person, animal, or reservoir to a susceptible host, either directly or indirectly through intermediate plant or animal host, vector, or the inanimate environment (air, soil, dust, water, food...).
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- ▶ **Contagious disease** is a slightly obsolete term, but if used nowadays it usually means “highly infectious”.
 - ▶ **Infection.** The entry and development or multiplication of an infectious agent in the body of man or animals. It also implies that the body responds in some way to defend itself against the invader, either in the form of an immune response only (evidence of this may not be readily available), or disease.
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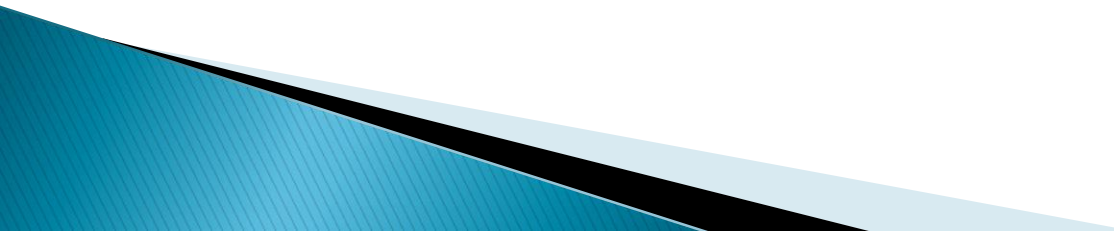
- ▶ However an infection does not always cause a clinically manifest t. Infection is not synonymous with infectious disease, the result may be inapparent or manifest.
- ▶ There are several levels of infection: ***colonization*** (e.g. *S. aureus* in skin and normal nasopharynx); ***subclinical*** or ***inapparent*** infection (e.g. 95% of polio, diphtheria); ***latent*** infection (e.g. virus of herpes simplex); and manifest or ***clinical*** infection.

- ▶ **Contamination.** The presence of an infectious agent on a body surface; also on or in clothes, bedding, toys, surgical instrument or articles or dressings, or other inanimate substances including water, milk and food. *Pollution* is distinct from contamination and implies the presence of offensive, but not necessarily infectious matter in the environment. Contamination on a body surface does not imply a carrier state.

- ▶ **Infestation.** For persons or animals the lodgment, development and reproduction of arthropods on surface of the body or in the clotting, e.g., lice, itch mite. Some authors use the term also to describe invasion of the gut by parasitic worms.
 - ▶ Infested articles or premises are those which harbor or give shelter to animal forms, especially arthropods and rodents.
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- ▶ **Agent-host relation on individual level (parasites affect individuals).**
 - ▶ Someone who has met with infections agent in a way that may cause disease has been *exposed*.
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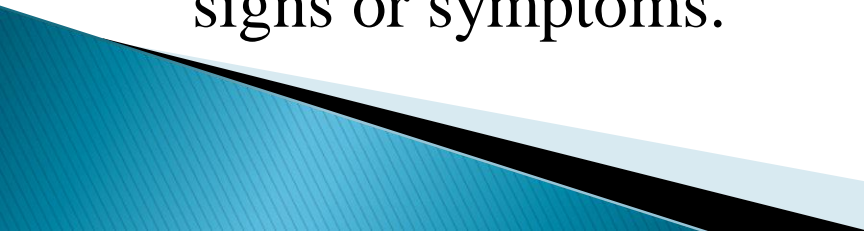
- ▶ **Exposure.** Proximity and/or contact with a source of a disease agent in such a manner that effective transmission of the agent or harmful effects of the agent may occur (Last's definition). This definition implies that the concept of exposure on present biological knowledge of transmission mechanisms, e.g. someone who passes a patient with Salmonella infection in a corridor has not been exposed to salmonella.

- ▶ On the contrary, if it is a patient with infection caused by measles virus he/she is considered to be exposed to measles. Similarly, a child that has been playing in the same room as another child with pertussis as been exposed to whooping cough.
 - ▶ If the infectious agent manages to get a foothold in the exposed person, he becomes *infected*.
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- ▶ Sometimes, this will lead to changes that are clinically evident or can be assessed by laboratory tests. The most obvious outcome is that he falls ill, i.e. has a *clinical infection*.
- ▶ Sometimes, the infected person will not display any symptoms, but can be shown serologically to have reacted to the infectious agent. He has then had a *subclinical* (or asymptomatic) infection.

- ▶ Both types of infection can lead to a carrier state for same diseases.
- ▶ A carrier harbors the pathogen, and is able to transmit it, but has no clinical signs of infection.
- ▶ For a few bacteria a somewhat different carrier state is also possible, e.g. Staphylococci, which a person might carry on his skin or in his nose and transmit to others. Such a person is locally *colonized*.

- ▶ Someone who has experienced an infection (clinical or subclinical) with a certain pathogen (or has been vaccinated against it) so that he shows no clinical signs of infection on renewed exposure to the same pathogen, is said to be *immune*.
- ▶ Sometimes it is possible to show by laboratory methods that an already immune person has reacted to exposure with an increased antibody titer, and this is called a *natural booster*.

- ▶ Those who are not immune to a disease and thus potentially infected by an exposure, are called *susceptible*.
 - ▶ To summarize, infection is the interaction of an agent and a susceptible host and implies development or replication of the agent in the host.
 - ▶ Disease is the clinical expression of the infection and is associated with development of signs or symptoms related to the infection.
 - ▶ In subclinical infections the victims have serological or microbiological evidence of infection without any clinical signs or symptoms.
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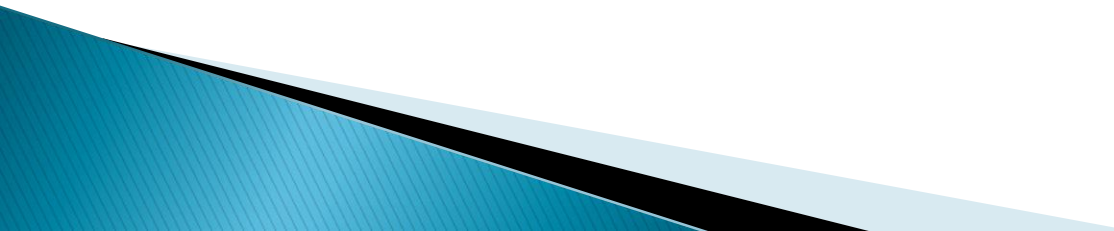
Agent-host relation on community level (parasites affect communities) this is the province of infectious disease epidemiology.

- ▶ **Sporadic**

- ▶ The word sporadic means occurring irregularly, haphazardly from time to time, and generally infrequently. The cases are few and separated widely in space and time and they show little or no connection with each other, nor recognizable common source of infection, e.g. tetanus, meningococcal meningitis, pertussis, measles. A sporadic disease may be the starting point of an epidemic when conditions are favorable for its spread. Many zoonotic diseases are characterized by sporadic transmission to man.

▶ **Epidemic**

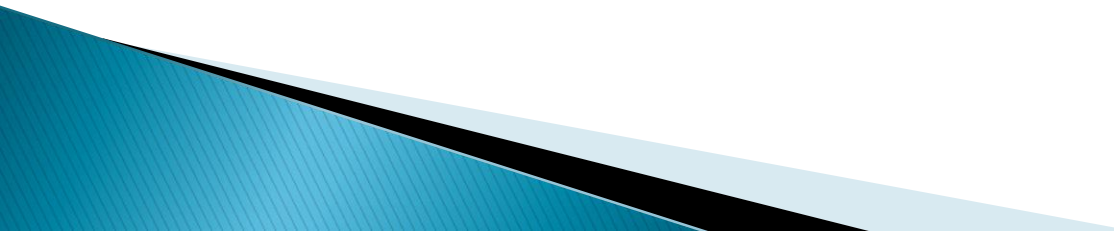
- ▶ Epi = upon; demos = people. The occurrence of cases of an illness clearly in excess of expectancy. When an epidemic is described, the time period, geographical region, and characteristics of community groups in which the cases occur must be clearly specified. The amount of disease occurring in the past, in the absence of an epidemic, defines the “expected” frequency. Some (public health officials) use the more neutral term “outbreak” for a small, usually localized epidemic in the interest of minimizing public alarm.

- ▶ The key words in the definition of an epidemic are: “in excess of normal expectancy”.
 - ▶ There is no agreement on what constitutes a significant excess.
 - ▶ An arbitrary limit of two standard errors from the endemic frequency is used to define the epidemic threshold for common diseases.
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- ▶ The number of cases indicating the presence of an epidemic varies according to the agent, the size and type of population exposed, and the time and place occurrence. A very small number of cases of a disease long absent from a population or first cases of a disease not previously recognized in an area, associated in time and place, may be sufficient to constitute an epidemic: e.g. cholera in Europe and USA, polio and polio-free countries.
- ▶ The word *epizootic* is used to describe an outbreak of disease in an animal population.

▶ **Endemic**

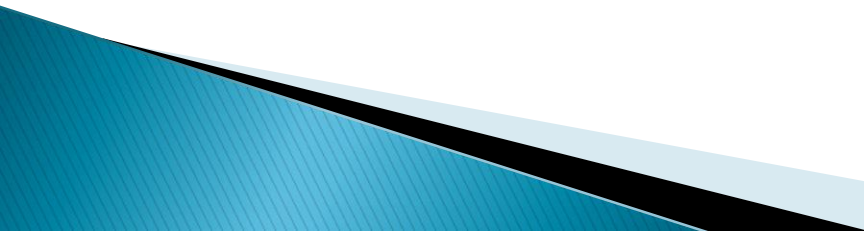
- ▶ En = in; demos = people. The constant presence of disease or infectious agent within a given geographic area or population groups (without importation from outside); may also refer to the usual prevalence of the disease within such area or group. The term “hyper-endemic” expresses that the disease is constantly present at a high incidence and/or prevalence rate and affects all age groups equally (e.g. hepatitis B in Africa and Southeast Asia).

- ▶ An endemic disease when conditions are favorable may become epidemic (e.g. hepatitis A, typhoid fever, many childhood infections).
 - ▶ As new control and preventive measures are applied, the endemic status of a disease may change (measles, polio, hepatitis B and other vaccine preventable diseases).
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▶ **Pandemic**

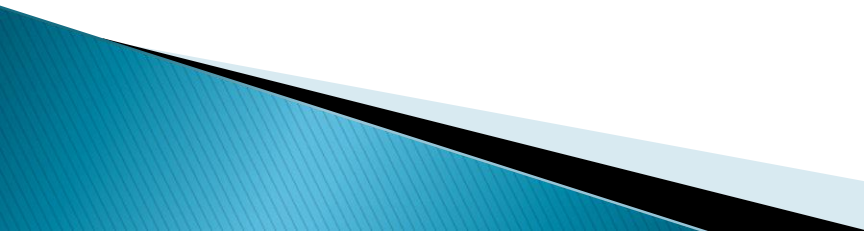
- ▶ An epidemic usually affecting a large proportion of the population and occurring over a wide geographic area such as a country, a continent or the world e.g. 4 influenza pandemic of 1918, 1957, 1968, 2009, cholera El Tor, started in 1962 (still continuing spread Latin America in 1991) and at present – HIV pandemic.

What is special about infectious disease epidemiology?

- ▶ In general, medicine provides knowledge about **the occurrence of diseases**. However, unlike the clinical disciplines which are concerned with the occurrence of disease in individual patients, epidemiology studies **the occurrence of disease in populations**.
 - ▶ There are three features that are quite unique to the infectious diseases and which they differ substantially from non-infectious diseases: etiology, transmission and immunity.
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Etiology

- ▶ Infectious disease results from the interaction between **an infectious agent and a susceptible host**. Obviously, causation of infectious disease is relatively simple and well-understood:
- ▶ The primary cause is the **specific microorganism** (disease agent) without which the particular disease cannot occur.

- ▶ The disease agent (causative agent, pathogen) can be described collectively as **invading living parasites** belonging to one of four classes of organisms:
 - ▶ 1/ parasites which are multi-cellular or single-celled animals (metazoa or protozoa);
 - ▶ 2/ fungi;
 - ▶ 3/ bacteria and
 - ▶ 4/ viruses.
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▶ If parasitism is to be successful, the infectious microorganism must:

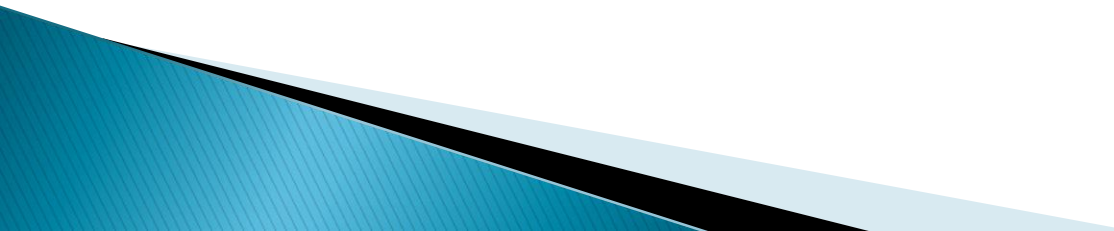
1/ **develop successfully and replicate** in sufficient numbers in the host to ensure survival of the species, and

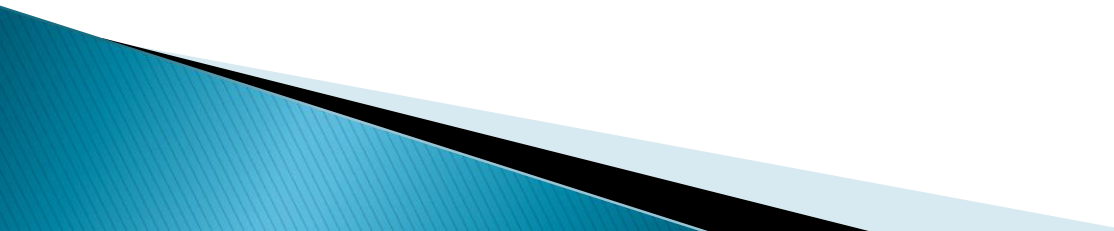
2/ the progeny of the parasite must **escape from the original host** (victim) and survive until additional hosts become available.

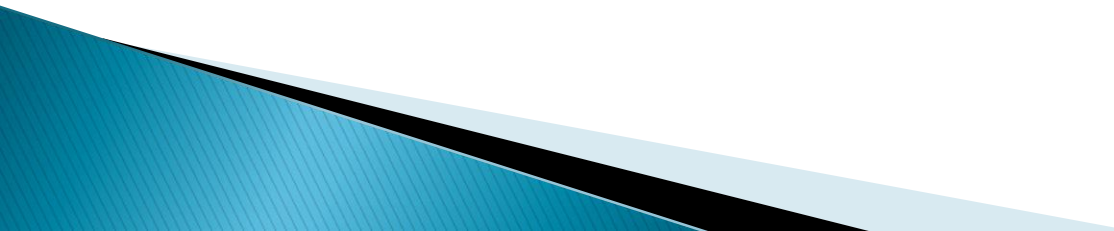
Four stages are described in the successful parasitism

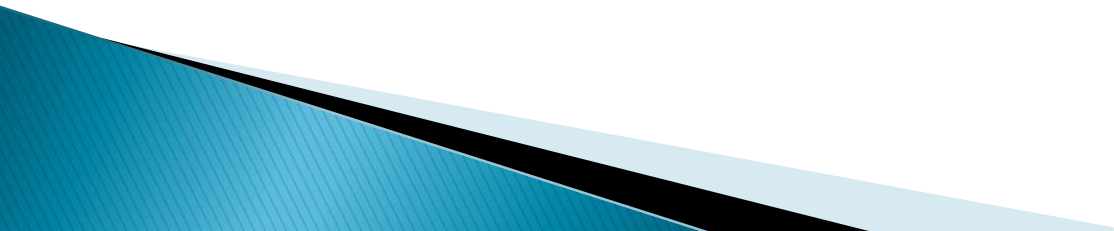
▶ The infectious agent must:

- 1/ Enter the host, or find a **portal of entry**, e.g. respiratory tract, alimentary tract, genitourinary tract, skin, ect. Some organisms may have **more than one portal of entry**, e.g. Hepatitis B virus, Francisella tularensis, Yersinia pestis, Bacillus anthracis.
- 2/ Reach the appropriate tissue, or “**site of election**” where to find optimum conditions for its survival and multiplication.

- 3/ Find a way out of the body or **portal of exit**, in order to find a new host and ensure the persistence of the species. Without a portal of exit the infection becomes dead-end like rabies, and bubonic plague.
- 4/ **Survive in the external environment** for enough long period of time until a new host becomes available.
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- ▶ If the **infectious agent** manages to get a foothold in the exposed person, he becomes infected (but infection may not occur).
 - ▶ The most obvious outcome of an infection is that the person falls ill, i.e. he has a **clinical infection**, or **clinical infectious disease** (but disease may not result). The disease is clinical expression of the infection and is associated with development of signs and symptoms specific for the infection.
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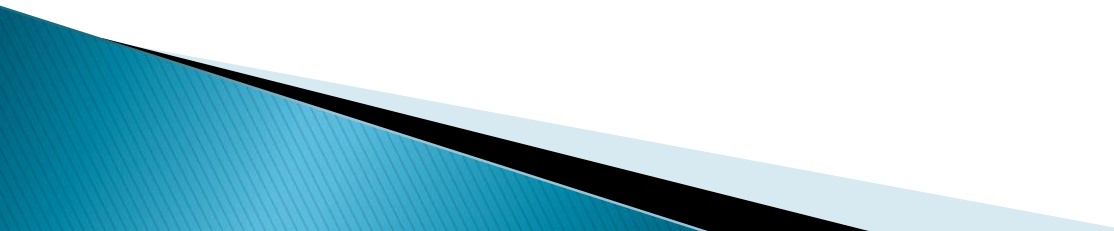
- ▶ **The clinical illness may range**
 - ▶ **from mild to moderate and severe, or fatal and**
 - ▶ **may be typical or atypical.**
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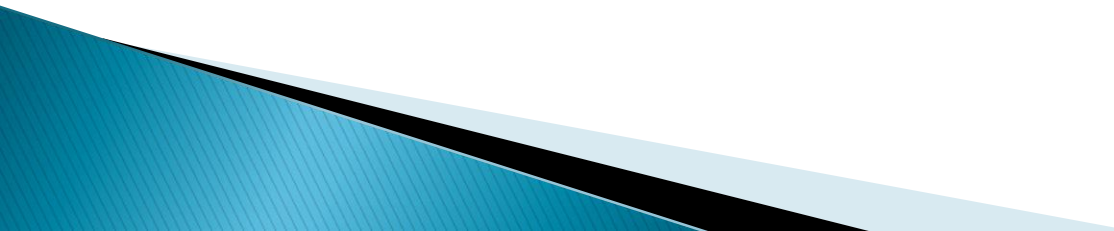
- ▶ Sometimes, the infected person will not display any symptoms, he has **subclinical (or asymptomatic) infection**. In subclinical infections the victims have serological or microbiological evidence of infection without any clinical signs or symptoms.
 - ▶ Both type of infection can lead to a **carrier state** for some diseases. A carrier harbors the pathogen, and is able to transmit it, but has no clinical signs of infection.
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There are four characteristics we use to define the behavior of the agent in the host: on the tabl. 1.

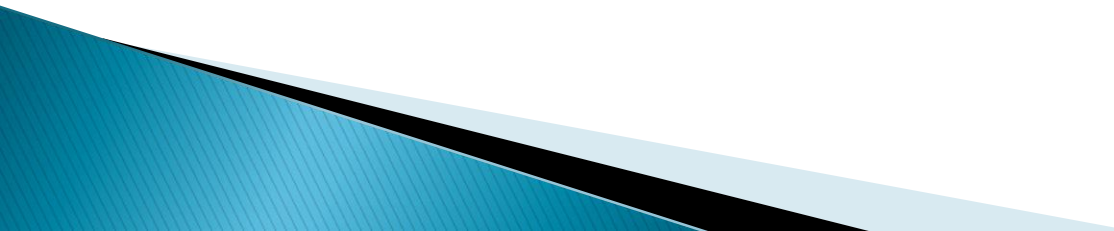
Agent	Host	Measure (for humans)
Infectivity Ability to invade and multiply in a host	Infection Entry and development of an infectious agent in the body of man or animal	Proportion of exposures that result in infection Secondary attack rate (SAR)
Pathogenicity Ability to induce disease	Infectious disease Illness due to a specific infectious agent or its toxic product	Proportion of infections that result in disease
Virulence “Degree of pathogenicity”	Severe cases or death	Number of severe cases over the total number of cases or case–fatality rate (CFR)
Immunogenicity Ability to induce immunity	Immune individuals (person, animals)	Degree (e.g. specific antibody titer) and duration of immunity

Disease control

- ▶ Disease control involves all the measures designed to prevent or control as much as possible the incidence, prevalence and consequences.
 - ▶ Control measures should not be delayed because of incomplete or lack of knowledge of etiological agent.
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Notification

- ▶ Once an infectious disease has been detected or even suspected, it should be notified to the local health authority, whose responsibility is to put into operation control measures. Notification is an important source of epidemiological information. It enables early detection of disease outbreaks, which permits immediate action to be taken by the health authority to control their spread.
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Notification

- ▶ Under the International Health Regulations (IHR), certain prescribed diseases are notified by the national health authority to WHO. These can be divided into:
- ▶ Those diseases subject to International Health Regulations (1969), Third Annotated Edition, 1983, Updated and Reprinted 1992: internationally quarantinable diseases – plague, cholera, yellow fever.

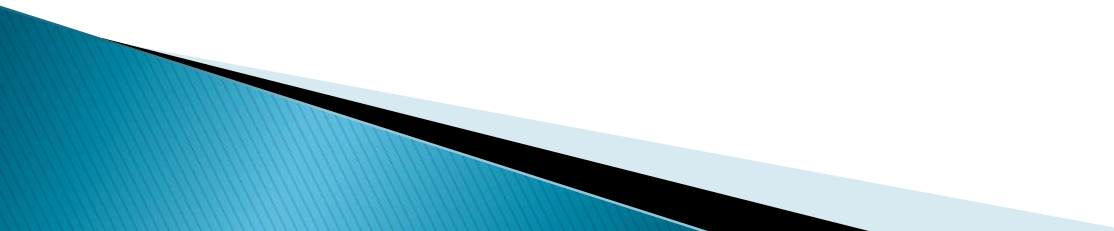
Notification

- ▶ Diseases under surveillance by WHO – louse-borne typhus fever, relapsing fever, paralytic poliomyelitis, malaria and influenza, etc.

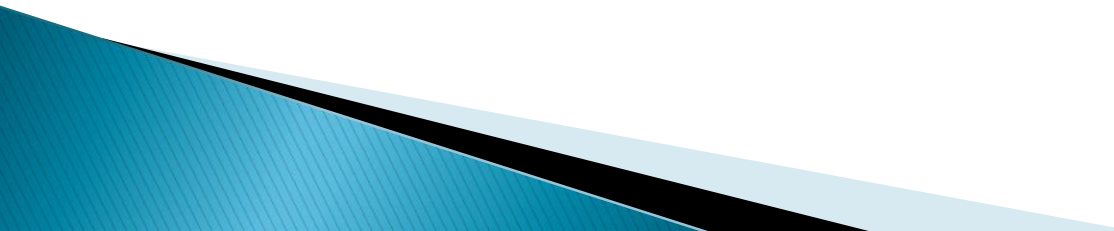
Isolation

- ▶ To protect the community by preventing transfer of infection from the reservoir to the susceptible hosts. In some disease: with a large component of subclinical infection and carrier state or highly infectious before they are diagnosed even the most rigid isolation will not prevent the spread of the disease.

Isolation

- ▶ Type of isolation varies with the mode of spread and severity of the disease (hospital vs. home isolation). Separation, for the period of communicability, of the infected person or animal from other such conditions as to prevent or limit the direct or indirect transmission of the infectious agent from those infected to those susceptible.
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Isolation

- ▶ **Strict isolation** (in highly contagious spread by both air and contact);
 - ▶ **Contact isolation** (diseases spread by close or direct contact);
 - ▶ **Respiratory isolation** (to prevent transmission over short distances through the air);
 - ▶ **Enteric precautions** (for infectious transmitted by direct or indirect contact with feces)
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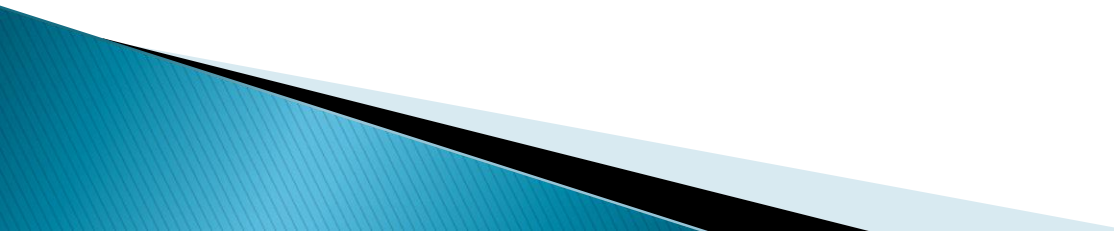
Isolation

- ▶ **Drainage / secretion precautions** (transmission by direct or indirect contact with purulent material or drainage from an infected body site);
- ▶ **Blood / body fluids precautions** (to prevent infections transmitted by direct or indirect contact with infected blood or body fluids. According to the type of isolation additional requirements are indicated for: masks, gloves and gowns, private room and special ventilation.

Isolation

- ▶ The duration of isolation is determined by the period of communicability and the effect of chemotherapy on infectivity.

Treatment

- ▶ To kill the agent in the reservoir, i.e. before its transmission;
 - ▶ Reduces the communicability of disease;
 - ▶ Reduces the duration of the disease;
 - ▶ Prevents development of secondary cases.
 - ▶ If treatment is inadequate or inappropriate it may induce drug resistance and compromise further attempts to control the disease by chemotherapy.
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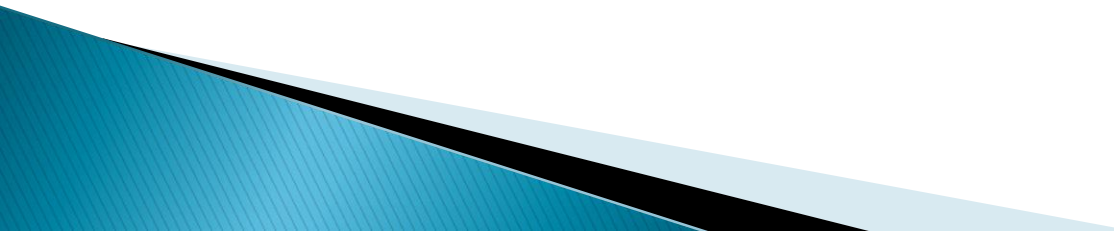
Quarantine

- ▶ In contrast to isolation applies to restrictions on the healthy contacts aimed to prevent their effective contact with persons not so exposed;
- ▶ Measures also applied to different means of transport (ship, train, aircraft...) to prevent the spread of disease, reservoir or vector of disease.

Interruption of transmission

- ▶ **Interruption of transmission:** breaking the chain of transmission; blocking the routes of transmission. Depends on the mode of transmission:
- ▶ **Vehicle-borne:** water and food (cholera, hepatitis A, acute diarrheal diseases) – water treatment, high standards of sanitation, adequate preparing and refrigeration of prepared foods will prevent such diseases.

Interruption of transmission

- ▶ **Vector-borne:** control measures directed at the vector and its breeding places, also control of stray dogs or other animal reservoir to minimize the spread among them.
 - ▶ **Droplet-spread** (or droplet nuclei) are not controlled affectivity by attempting to interrupt their mode of spread.
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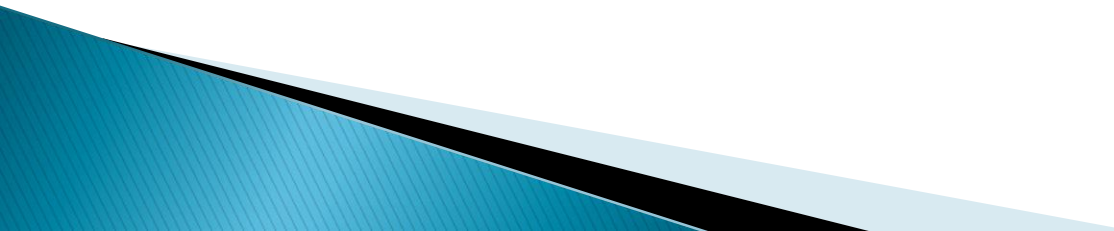
Susceptible host

- ▶ **The susceptible host** – controlling the spread by strengthening the host defenses: Immunization (active, passive and combined) or by Chemoprophylaxis (causal or clinical).

Surveillance – an essential part of disease control

- ▶ **Definition of public health surveillance: Routine collection, analysis and dissemination of all data that may be relevant for the prevention and control of a public health problem.**

Surveillance

- ▶ Surveillance includes the systemic collection and evaluation of:
 - ▶ Morbidity and mortality reports;
 - ▶ Special reports of field investigations (epidemic or individual cases);
 - ▶ Laboratory data – isolation and identification of infectious agents
 - ▶ Data concerning vaccine coverage and adverse effects of vaccines;
 - ▶ Data regarding the immunity level in groups of population (serosurveys);
 - ▶ Other relevant epidemiologic data.
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Reporting system

- ▶ Routine system of reporting cases within the health system – the most important way to organize a system of surveillance for communicable disease control.
- ▶ **A reporting system functions at 4 levels:**
 1. First level – collection of the basic data in the local community (where the disease occur).
 2. District (state or provincial) level – data are assembled.
 3. National level – aggregation of information for the country
 4. Certain prescribed diseases are reported by the national health authorities to the WHO.

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- ▶ Routine system of reporting cases within the health system – the most important way to organize a system of surveillance for communicable disease control.
- ▶ **A reporting system functions at 4 levels:**
 1. First level – collection of the basic data in the local community (where the disease occur).
 2. District (state or provincial) level – data are assembled.
 3. National level – aggregation of information for the country
 4. Certain prescribed diseases are reported by the national health authorities to the WHO.