

Microbiology

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Unit 09 Microbiology

9.2.0 : Investigates micro-organisms as human pathogen

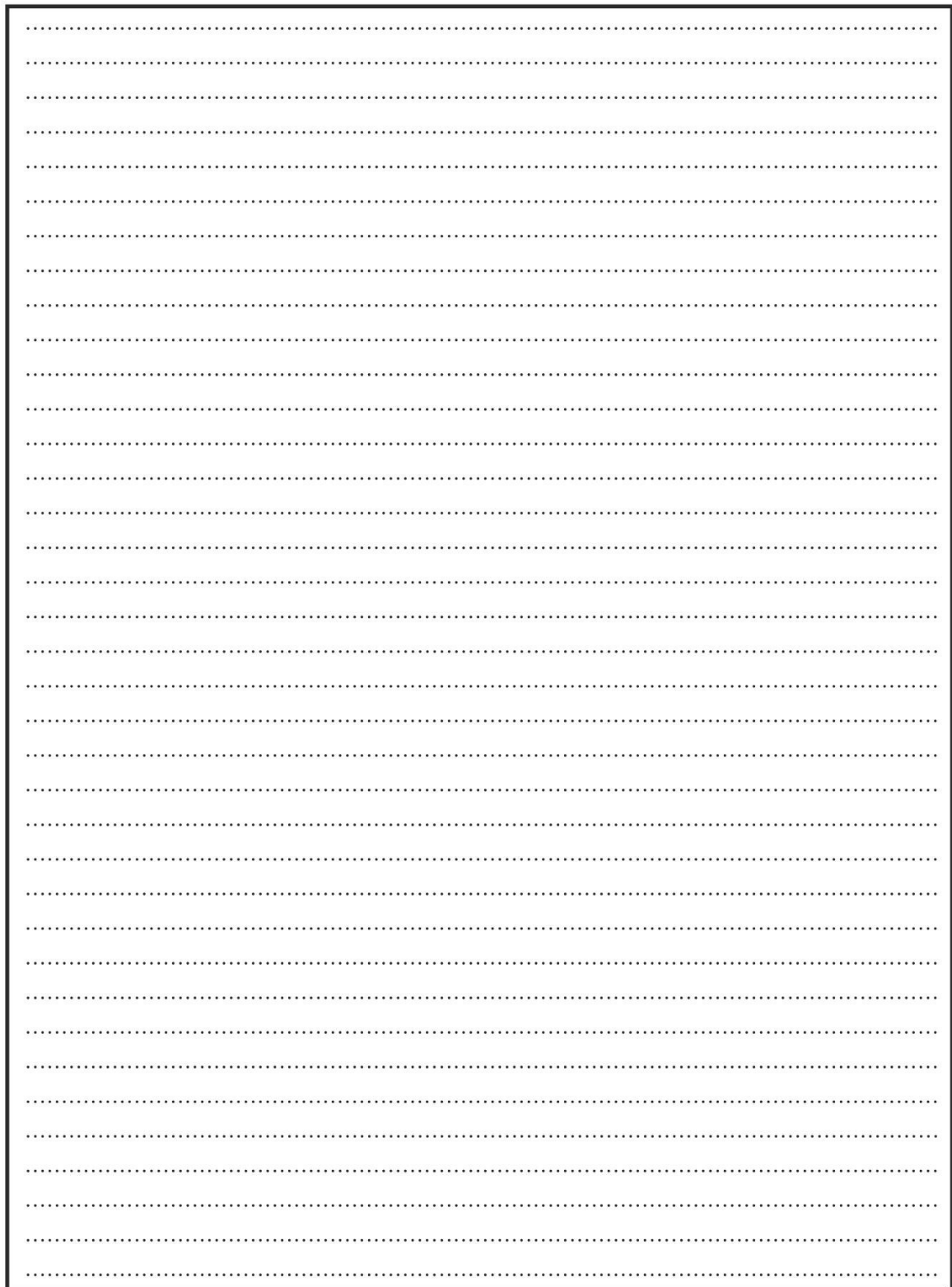
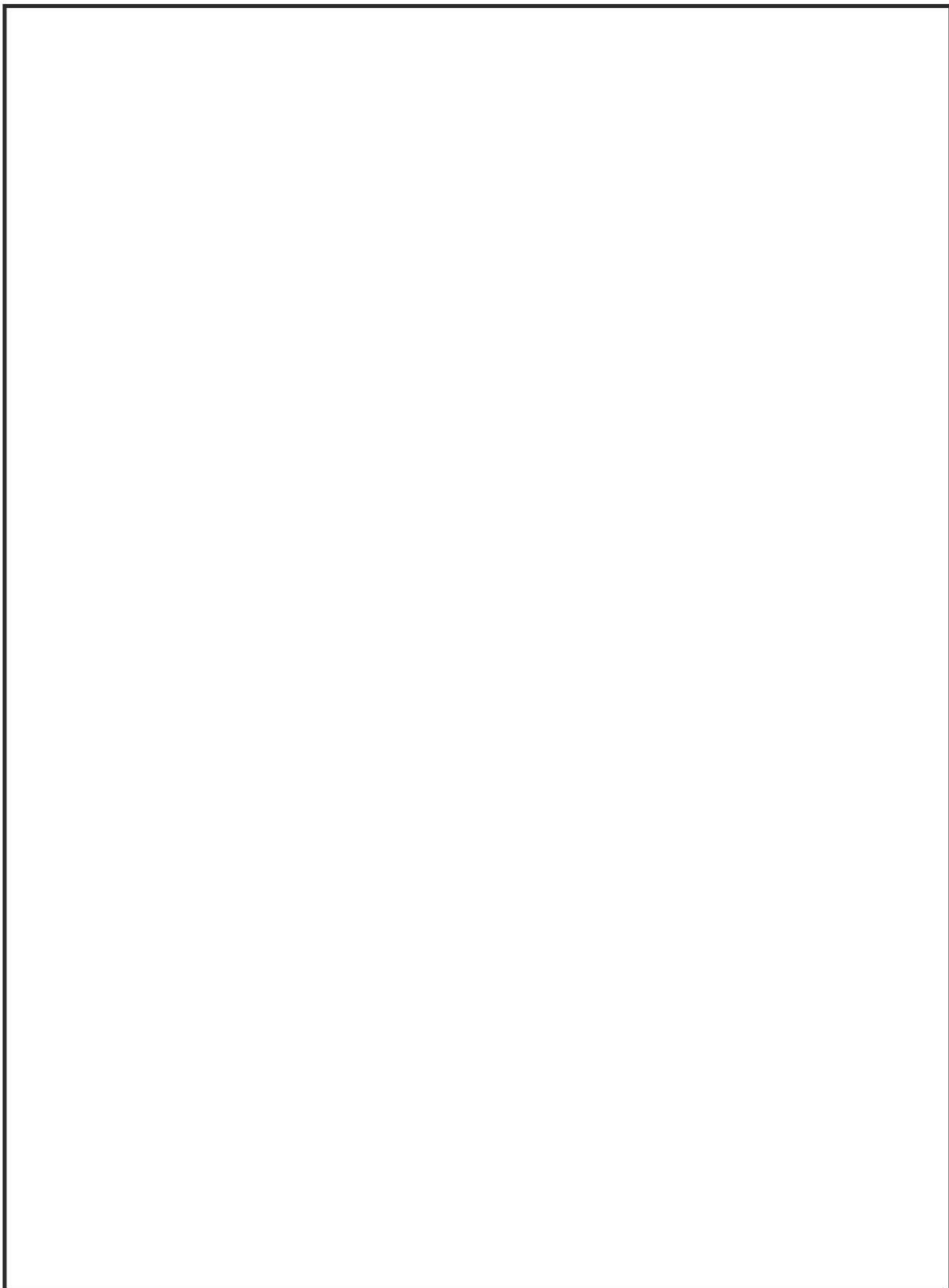
9.2.1 : Explores the concepts, principles relevant to infectious diseases

9.2.2 : Explores the methods of controlling microbial population



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2017 AL

3. State two features of toxins produced by *Clostridium tetani*
.....
.....

2019 Old

4. (i) Name the type of exotoxin produced by each of the following pathogens.
Corynebacterium diphtheriae :
Clostridium tetani :
Vibrio cholerae :

(ii) (a) A person develops immunity against chickenpox when infected once with it. What is the type of this immunity?
.....

(b) Name the type of specific molecule which causes immunity.
.....

2021 AL

(iv) Name a fungal species and a bacterial species that cause food intoxication.
Fungal species :
Bacterial species :

(a) State two differences between sub—unit vaccines and live attenuated vaccines.
.....
.....
.....

2023 AL

(ii) Name one virus each that causes diseases in the following:
(a) Nervous system :
(b) Digestive system :

Essay

AL 2001

1. (i) What is understood by the, terms pathogen and virulence in relation to microorganisms?

A/L 1995

2. (a) What is meant by acquired immunity? Explain the different types of acquired immunity in man. Give one example to illustrate each type of immunity.
(b) Name the causative organism and the methods of transmission of each of the following disease:
(i) Tuberculosis (ii) Cholera (iii) Chicken pox (iv) Botulism (v) AIDS

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9.2.0 : Investigates micro-organisms as human pathogens

9.2.1 : Explores the concepts, principles relevant to infectious diseases

Microorganisms and diseases

- Generally, humans are free of microorganisms at However, during birth, the newborn first get in contact with microorganisms present on the of mother. Usually, these are Lactobacilli colonize the intestine of the newborn. After birth, many other microbial populations begin to establish or on the of the body. These are called of human body. However, internal tissues of healthy human body are free of microorganisms.
- A part of these microorganisms colonize on the skin, and majority enter the body and colonize on the surfaces such as membranes of, throat, upper respiratory tract, intestinal tract and genitourinary tract. A normal healthy body contains a large number of microorganisms. It has been estimated that the human body consists ofmicrobial cells for total body cells, which means a times more microbial cells than human cells.
- Majority of these organisms are generally harmless or even For example, minimal colonization of *Escherichia coli* at prevent colonization of pathogenic bacteria such as, *E. coli* in large intestine synthesizes vitamin and some of the vitamins that are absorbed into the bloodstream and used by body cells.
- Recent interest in the importance of bacteria to human health has led to the study of Probiotics are live microbial cultures. Eg. Yoghurt exert a beneficial effect. (Prebiotics are a type of fiber that the human body cannot digest. They serve as food for probiotics, which are tiny living microorganisms, including bacteria and yeast. Both prebiotics and probiotics may support helpful bacteria and other organisms in the gut)
- Several studies have shown that ingestion of certain lactic acid bacteria can and prevent colonization by during antibiotic therapy. Although majority of human microbiota are, some of them may change their interactions with human body under certain conditions and cause infections. Those microorganisms are called opportunistic pathogens. For example, *E. coli* is generally harmless as long as it remains in the large However, they may cause diseases, if enter other body parts (urinary bladder-urinary tract infection, lungs- pulmonary infection).

Terms related to infectious diseases

Pathogen:

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Host:

- Organism within which infected pathogens live on or in and multiply.

Pathogenicity:

- The ability of a pathogen to cause disease in the host by overcoming the defense of a host.

Parasite:

- An organism or entity living on or in another living organism (host) and obtain nutrients and other resources from the host.

19. Which of the following sites in a healthy human body is not a natural habitat of microorganisms?
 (1) Skin (2) Lungs (3) Small intestine (4) Buccal cavity (5) Genital organs (2013/38)
20. A person who had an infection of measles rarely develops the same infection again.
 This is an example of
 (1) nonspecific immunity. (2) artificially acquired passive immunity.
 (3) artificially acquired active immunity. (4) naturally acquired active immunity.
 (5) naturally acquired passive immunity. (2013/39)
21. Active immunization is more advantageous than passive immunization because
 (1) it provides immediate protection from diseases. (2) chance of an allergic reaction is less.
 (3) its effect lasts for a long time. (4) it does not require revaccination. (5) it is hereditary. (2013 old/40)
22. Administration of anti tetanus vaccine is an example of
 (1) artificially acquired passive immunity. (2) artificially acquired active immunity.
 (3) naturally acquired passive immunity.
 (4) a routine vaccination procedure in public health to prevent tetanus.
 (5) naturally acquired active immunity. (2014/38)

Structured Essay

2006 AL

1. (i) With reference to microbial disease, briefly explain the following terms.
 (a) Pathogenicity.....
 (b) Invasiveness
 (c) Toxigenicity
- (ii) Name two extracellular enzymes that contribute to invasiveness and state one function of each of these enzymes.

Enzyme	Function
.....
.....

- (iii) What are antibiotics?

- (iv) Name two commonly used antibiotics and state the mode of action of each of them.

Name of antibiotic	Mode of action
.....
.....

2014 AL

2. (i) Pathogenic microorganisms enhance pathogenicity by producing exotoxins and endotoxins.
 (a) What are endotoxins?

- (b) Give an example for a bacterium that produces endotoxins?

- (c) What are exotoxins?

- (d) Name three different types of exotoxins and name three different species of bacteria that produce them.
- | Type of exotoxin | Name of the bacterium |
|------------------|-----------------------|
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- (2) Extracellular enzymes produced by some microorganisms are responsible for disease production.
 (3) Endotoxins produced by bacteria are heat labile
 (4) Human skin prevents the establishment of some pathogenic microorganisms.
 (5) Inflammatory response is a mechanism for prevention of the spread of an infection from the original site.
6. Which of the following pathogenic bacterium produces an endotoxin?
 (1) *Clostridium tetani* (2) *Vibrio cholera* (3) *Corynebacterium diphtheria* (4) *Salmonella typhi*
 (5) *Staphylococcus aureus*
7. Which one of the following bacteria produces a neurotoxin?
 (1) *Salmonella typhi* (2) *Clostridium tetani* (3) *Pseudomonas aeruginosa* (4) *Corynebacterium diphtheria*
 (5) *Vibrio cholera*
8. Antimicrobial activity of penicillin depends on
 (1) inhibition of DNA replication in bacteria. (2) inhibition of synthesis of cell walls of bacteria.
 (3) inhibition of protein synthesis in bacteria. (4) inhibition of folic acid synthesis in bacteria.
 (5) inhibition of membrane transport systems in bacteria.
9. The antibiotic erythromycin destroys bacteria by
 (1) Inhibiting the cell wall synthesis. (2) Inhibiting protein synthesis. (3) Inhibiting DNA replication.
 (4) Inhibiting synthesis of cell membrane. (5) Causing leakages in cell membrane.
10. Out of the following pathogens, which bacterium causes a disease mainly by the production of nerve-toxins?
 (1) *Corynebacterium diphtheria* (2) *Vibrio cholera* (3) *Clostridium tetani* (4) *Salmonella typhi*
 (5) *Staphylococcus aureus*.
11. Which of the following pathogenic organisms produce an endotoxin?
 (1) *Clostridium botulinum* (2) *Salmonella typhi* (3) *Vibrio cholera* (4) *Corynebacterium diphtheria*
 (5) *Staphylococcus aureus* (AL/2012)
12. Which of following is/are example/examples of passive immunity?
 (A) Immunity developed in new born babies by antibodies passing through placenta of the mother.
 (B) Immunity developed in a person who has contacted measles.
 (C) Immunity developed by vaccination of a healthy persons with polio vaccine.
 (D) Immunity developed after vaccination of a person who has been bitten by a rabid dog.
 (E) Immunity developed in certain individuals against malaria. (2011 Prototype)
13. Which of the following antimicrobial drugs inhibit the growth of bacteria by inhibiting the synthesis of DNA?
 (1) Penicillin (2) Rifampin (3) Daptomycin (4) Erythromycin (5) Clotrimazole (AL/2011)
14. Which of the following organisms produces exotoxins?
 (A) *Saccharomyces cerevisiae* (B) *Acetobacter aceti* (C) *Clostridium tetani* (D) *Corynebacterium diphtheriae*
 (E) *Salmonella typhi* (A/L 2011)
15. Which of the following groups of diseases are usually transmitted through food/water
 (1) Tetanus, Measles, Tuberculosis (2) Chickenpox, Typhoid, Cholera (3) Typhoid, Cholera, Botulism
 (4) Pneumonia, Polio, Typhoid (5) Tuberculosis, Influenza, Leptospirosis (AL/2011 Old)
16. Many pathogenic bacteria produce toxins which disrupt normal function of cell during an infection. Which of the following bacteria produce a neurotoxin?
 (1) *Cornebacterium diphtheriae* (2) *Clostridium botulinum* (3) *Salmonella typhi* (4) *Vibrio cholera*
 (5) *Staphylococcus aureus* (AL/2010)
17. Which of the following diseases is/ are caused by bacteria?
 (A) Typhoid (B) Poliomyelitis (C) Leptospirosis (D) Botulism (E) Rabies (2012/50)
18. In many regions of the world where tuberculosis is common, infants receive the BCG vaccine for protection against it. This is an example for
 (1) artificial passive immunity. (2) artificial active immunity. (3) natural active immunity.
 (4) production of antibodies for general immunity. (5) natural passive immunity (2012 Old/38)

Characteristics of pathogenic microorganisms

- Having optimal growth conditions (Eg: Temperature) that corresponds to the body conditions of the host.
- Having structures to adhere to the host cells and protect against host's defense mechanisms. Eg. Capsule, Pilli
- Produce toxins; endotoxins or exotoxins.
- Having enzymes for invasiveness such as phospholipase, lesithinase, and hyaluronidase.
- Having enzymes such as DNase to alter the host's metabolic processes.

Virulence and virulent factors

- Microbes express their pathogenicity by means of their virulence. Virulence is the degree of pathogenicity of the pathogen. Some pathogens are highly virulent (chicken pox virus) whereas others are less virulent/ non virulent.
- Few genes of pathogenic microorganisms express factors which provide them the ability to infect their host and cause disease. Such factors are called virulent factors.
- The relationship between a host and a pathogen is dynamic, each modifies the activities and functions of the other. As a result, outcome of such a relationship depends on the virulence of the pathogen and the effectiveness of the host defense mechanisms.
- Virulence factors enhance the pathogenicity and allows pathogen to invade and colonize host tissues and disrupt normal body function. Pathogens use two major mechanisms for pathogenicity.



- Antibiotics show various modes of action. Some examples are given below.
 1. -
 2. -
 3. -
 4. -

Immunization: Vaccines

- A vaccine is a suspension of or that is used to Vaccines are frequently used to control diseases caused by because there is no once infected. There are several types of vaccines.

1. Live attenuated vaccines

- Vaccine contains live pathogens which were deliberately weakened for its pathogenicity. These vaccines, mimic an actual infection. Since the pathogen is active inside the host, such vaccines provide lifelong immunity. More often a booster (secondary) immunization is not required. Examples for live attenuated vaccines are, vaccines for,
 - Measles, Mumps and Rubella (MMR)
 - Chickenpox

2. Inactivated vaccines

- Pathogenic microorganism is inactivated or killed in the vaccine. Compared to live attenuated vaccines, inactivated killed vaccines often require repeated booster doses. Examples for inactivated vaccines are vaccines for,
 - Virus diseases such as Rabies, Influenza, Polio
 - Bacterial diseases such as Cholera

3. Subunit vaccines

- Subunit vaccines contain only the antigenic fragments of a pathogen that can induce immunity in the recipient. Toxoid vaccines are the best examples for subunit vaccines, those have been used for a long time. Toxoids contain inactivated toxins derived from a pathogen. Examples for Toxoid vaccines are vaccines for Tetanus, Diphtheria, etc. Presently, subunit vaccines are produced using genetic engineering.
Eg. Hepatitis - B Vaccines. Subunit vaccines usually require repeated booster dose to obtain full immunity.

MCQ

1. The type of immunity produced in an individual following injection of toxoid is known as

(1) naturally acquired passive immunity.	(2) naturally acquired hereditary immunity.
(3) naturally acquired active immunity.	(4) artificially acquired passive immunity.
(5) artificially acquired active immunity.	
2. Which one of the following antibiotics inhibits bacterial growth by damaging cell membranes of bacteria?
(1) Rifampin (2) Penicillin (3) Tetracycline (4) Daptomycin (5) Erythromycin
3. Microorganisms were first observed and recorded by
(1) Louis Pasteur in France. (2) Robert Koch in Germany. (3) Anton Van Leewenhoek of Holland.
(4) Robert Hook in England. (5) Paul Ehrlich in Germany.
4. Which of the following organisms is responsible for infections due to the production endotoxins in spoilage?
(1) *Salmonella typhi* (2) *Vibrio cholera* (3) *Shigella dysenteriae* (4) *Staphylococcus aureus*
(5) *Clostridium botulinum*
5. Which of the following is **incorrect** regarding microorganisms and diseases?
(1) Microorganisms are found also in the intestine of healthy humans.

9.2.2 : Explores the methods of controlling microbial population

Avoidance and prevention of microbial diseases

- Good hygienic practices in day to day life is the best method to avoid infectious diseases. Antiseptics, disinfectants and immunization play import role in prevention of infection.

Methods of controlling microbial diseases of human

Use of antiseptics and disinfectants

- Antiseptics and disinfectants are However, such chemicals are not effective against some microorganisms. For example, polio virus, tuberculosis bacterium, spores of bacteria and fungi are destroyed by most antiseptics and disinfectants.
- The major difference between antiseptics and disinfectants is that , whereas disinfectants cannot. Therefore, antiseptics are used in disinfection of living surfaces such as skin. Disinfectants are used in disinfection of surfaces such as operation theatres, bathing areas, sinks, kitchen tops, cutlery, drains etc.
- Antiseptics and disinfectants are generally formulated as liquids. Their effectiveness varies with of exposure, and presence of organic matter.
- Some examples of antiseptics and disinfectants are given below.
Antiseptics :
Disinfectants :

Use of Antibiotics in controlling microbial diseases

- When the body's defense fails to protect body from the infection or overcome the disease, it has to be treated by chemotherapy with antimicrobial drugs. Antimicrobial drugs of microorganism without Antibiotics are effective antimicrobial drugs against bacteria.
- Some antibiotics affect against a broad range of bacteria and they are termed as antibiotics, while others affect only against a specific group of bacteria and are called narrow-spectrum antibiotics.

1. Invasiveness

-
.....
- Several extracellular enzymes produced by pathogens contribute to invasiveness.
Eg:
..... - Destroy animal
..... - Hydrolyzes the component of the lipid in the cell membrane.
..... - Destroys the body tissue by breaking down the hyaluronic acid which is cementing substance between cells.
- Pathogenic microorganisms do enter passively through various portals or natural openings such as wounds on skin, respiratory, gastrointestinal and genito-urinary tracts.

2. Toxigenicity

-
.....
These are proteins or lipopolysaccharides that produce specific harmful effects on the host, thus are called
- They may be,
• Endotoxins - Endotoxins are These are toxins which are part of the microbial cell. Toxins are released when the bacteria and the apart. All endotoxins cause the same signs of symptoms regardless of the species of pathogen. These symptoms include,,, generalized and sometimes and Endotoxins are produced only by gram-..... bacteria
Eg. Lipopolysaccharides of the cell walls of *Salmonella typhi*
- Exotoxins - Exotoxins are produced bacterial cells as part of their growth and metabolism and are secreted or released to the surrounding environment after cell lysis. Exotoxins are Majority of them are Due to their nature even a of toxin is quite harmful. These are protein toxins, being inactivated by boiling. Exotoxins are most commonly produced by gram-..... bacteria and a gram negative bacteria.
- Exotoxins are classified into three types
 1. Neurotoxins
 - Interfere with normal transmission of nerve impulses.
Eg. Toxins produced by *Clostridium tetani*
 2. Enterotoxins
 - Stimulates cells of the gastrointestinal tract in an abnormal way.
Eg. Toxins produced by *Vibrio cholera*
 3. Cytotoxins
 - Kills host cells by enzymatic attack.

Eg. Toxins produced by *Corynebacterium diphtheriae*.

Important Diseases of Human Caused by Microorganisms

Organ	Disease	Causal agent
Skin	Chickenpox	Herpesvirus varicella-zoster
	Rubella	Rubella virus
	Measles	Measles virus
Eye	Conjunctivitis (bacteria/virus)	<i>Haemophilus influenza</i> Adenovirus
Nervous system	Bacterial meningitis	<i>Streptococcus pneumonia</i> <i>Haemophilus influenzae</i> <i>Neisseria meningitidis</i>
Nervous system	Tetanus	<i>Clostridium tetani</i>
	Rabies	Rabies virus
Cardiovascular system	Rheumatic fever	<i>Streptococcus pyogenes</i>
Respiratory system	Tuberculosis	<i>Mycobacterium tuberculosis</i>
	Influenza	Influenza virus
	Pneumonia	<i>Streptococcus pneumoniae</i>
Digestive system	Hepatitis	<i>Hepatitis A virus</i>
	Food poisoning	<i>Staphylococcus aureus</i>
	Cholera	<i>Vibrio cholerae</i>
	Typhoid	<i>Salmonella typhi</i>
Urinary system	Leptospirosis	<i>Leptospira interrogans</i>
Reproductive system	Gonorrhoea	<i>Neisseria gonorrhoeae</i>
	Genital herpes	Herpes simplex virus
Immune system	AIDS	Human immune deficiency virus (HIV)

- Microbial disease control starts from avoidance and prevention of opportunities of getting infection to treatment or curative methods after infection.

