Chapter 9 Pharmacology

Section A Multiple Choice Questions (M.C.Qs)

Choose the correct answer:

01. *Who is called the father of antiseptics?*
(a) Alexander Fleming (b) Edward Jenner (c) Lister (d) Oswald Schmiedberg

02. *Drugs for treatment of rheumatoid arthritis can be obtained from:*
(a) Animals (b) Minerals (c) Plants (d) Microorganisms

03. *Drugs that slow normal brain functioning are categorized as:*
(a) Narcotics (b) Hallucinogen (c) Marijuana (d) Sedatives

04. *Vaccination can be administered:*
(a) after infection (b) before infection (c) during infection (d) All are correct

05. *The substance which inhibits the growth of bacteria can be considered as:*
(a) Vaccine (b) Bactericidal (c) Bacteriostatic (d) Antibiotics

06. *Haris is addicted to a drug, which left the following effect on Haris:*
(i) Blurred vision (ii) Making unseen faces in imagination (iii) Euphoria
Identify the drug to which Haris is addicted?
(a) Narcotics (b) Hallucinogen (c) Antibiotics (d) Antiseptic

07. *Which one is not the effect of misuse of antibiotics?*
(a) Diarrhea (b) Immunization (c) Stomach upset (d) Antibiotic resistance

08. *He is generally recognized as the founder of modern pharmacology.*
(a) Alexander Fleming (b) Edward Jenner (c) Lister (d) Oswald Schmiedberg

09. *Cinchona tree contains Quinine in its bark which is used in the treatment of:*
(a) malaria (b) pain (c) diarrhea (d) upset stomach

10. *Opium is used as a/an:*
(a) antiseptic (b) antibiotics (c) pain-killer drug (d) vaccine

11. *Gonadotropin hormones are prepared commercially from:*
(a) horse serum (b) the urine of pregnant woman
(c) Both 'a' & 'b' (d) None of these

12. *Hyaluronidase enzyme is produced by some microorganisms, found in the:*
(a) heads of leeches (b) snake venom (c) mammalian testes (d) All of these

13. *Penicillin, Cephalosporin and Tetracycline are:*
(a) pain killers (b) antibiotics (c) vaccine (d) sedatives

14. ***It prevents the living body from microbial diseases by developing immunity in the body.***
(a) antiseptic *(b)* antibiotics *(c)* pain-killer drug *(d)* vaccine

15. ***These drugs help treat anxiety and sleep problems.***
(a) Sedatives *(b)* Pain killers *(c)* Antibiotics *(d)* Vaccine

16. ***Joseph Lister used this as a disinfectant.***
(a) sulphuric acid *(b)* hydrochloric acid *(c)* carbolic acid *(d)* oxalic acid

17. ***He discovered penicillin in 1928.***
(a) Alexander Fleming *(b)* Edward Jenner *(c)* Joseph Lister *(d)* Oswald Schmiedberg

18. ***They are antimicrobial substances that are applied to living tissue/skin to prevent microbial infection.***
(a) Sedatives *(b)* Antiseptics *(c)* Antibiotics *(d)* Vaccines

19. ***In 1796, the first vaccine was introduced by a British physician:***
(a) Alexander Fleming *(b)* Edward Jenner *(c)* Joseph Lister *(d)* Oswald Schmiedberg

Answers

1. (c)	2. (b)	3. (d)	4. (d)	5. (d)	6. (a)	7. (b)
8. (d)	9. (a)	10. (c)	11. (c)	12. (d)	13. (b)	14. (d)
15. (a)	16. (c)	17. (a)	18. (b)	19. (b)		

Section B&C — Short & Detailed Answer Questions

Q.1 ***Define pharmacology.***

Ans: ***Pharmacology:*** Pharmacology is the branch of biomedical science that is concerned with the uses, effects, and modes of action of drugs. This branch is studied under the discipline of pharmacy.

Q.2 ***Who are pharmacists?***

Ans: ***Pharmacists:*** One who studies pharmacy responsible for dispensing prescription medications to patients and advising them are called pharmacists.

Q.3 ***Who is recognized as the founder of modern pharmacology?***

Ans: Pharmacology, as we know it today, became a scientific discipline in the early 19th century, when many physiologists began to perform pharmacologic studies.
Oswald Schmiedeberg (1838-1921) is generally recognized as the founder of modern pharmacology. He studied the pharmacology of chloroform and chloral hydrate.

Q.4 ***How can you define drugs and their types?***

Ans: ***Drugs:*** Patients are treated with drugs. A drug is a chemical substance used to treat, cure, prevents

a disease or to promote well-being or artificial pleasure. Drugs can be derived from plants and animals. There are two categories of drugs:

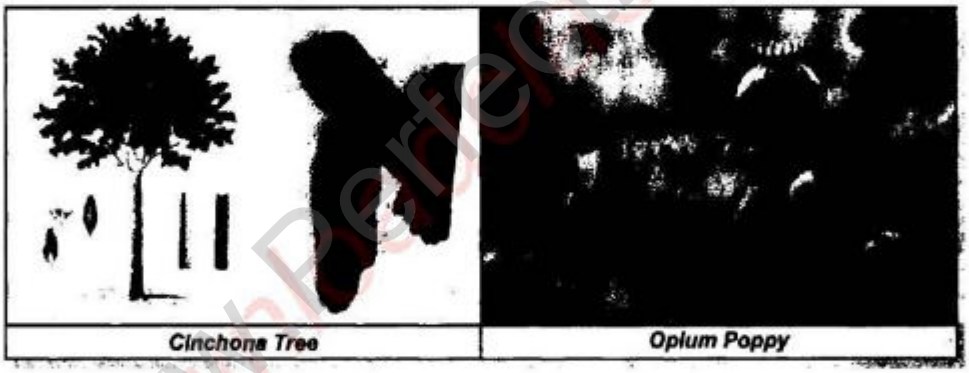
(i) ***Pharmaceutical Drugs:*** Pharmaceutical drugs or medicinal drugs are used to treat the diseases and makes the patient physically normal.

(ii) ***Addictive Drugs:*** Addictive drugs makes the person relaxed by feeling pleasure, acting on the CNS of the person, finally the person becomes dependent on it.

Q.5 Describe the sources of medicinal drugs.

Ans: ***Medicinal Drugs:*** Medicinal drugs are beneficial for the patients as these drugs treat the disease to prevent them so many of the diseases can easily be cured. These beneficial drugs are obtained from various sources:

(i) ***Drugs from Plants:*** Many plants produce special substances in their roots, leaves, flowers, or seeds that help to form drugs in a laboratory or can be used directly as herbs. For example, the cinchona tree contains Quinine in its bark which is used in the prevention and treatment of malaria and Opium is used as a pain-killer drug extracted from the unripe seed pods of the opium poppy.



Cinchona Tree | Opium Poppy

(ii) ***Drugs from Microorganisms:*** Microorganisms such as bacteria and fungi not only produce many primary metabolites; they are also capable of making secondary metabolites, which constitute half of the pharmaceuticals on the market as antibiotics and antifungal drugs.
Example: Tetracycline is produced by bacteria and Lovastatin is produced by fungi.

(iii) ***Drugs from Animals:*** Certain animal parts and animal products are used as a drug in therapeutics. The major group of animal products used in medicine is a hormone, enzymes, animal extractives, organs and bile acids.
For example, Gonadotropin hormone is prepared commercially from either horse serum or the urine of pregnant women.

> Today, scientists are more excited about drugs derived from the sun anemone.

They control the production of sex hormones in the body. Hyaluronidase enzyme is produced by some microorganisms, found in the heads of leeches, in snake venom and mammalian testes.

(iv) ***Drugs from Minerals:*** Some of the drugs are synthesized from minerals or can be given with minerals as a supplement, such as iron is used in the treatment of iron deficiency

(anaemia). Zinc is used to make zinc oxide paste which is used in wounds and eczema. Gold salts are used in the treatment of rheumatoid arthritis etc.

(v) ***Synthetic Drugs:*** Synthetic drugs are synthesized in labs by using man-made chemicals rather than natural ingredients. A number of synthetic drugs in the market are available.
Example: Synthetic marijuana goes by many names: K2, Spice, fake pot, potpourri, legal weed and more.

There are more than 20 identified synthetic drug compounds and more than 90 different synthetic drug marijuana compounds.

Q.6 Describe the principal usage of important medicinal drugs.

Ans: ***Principle Usage of Important Medicinal Drugs***

(i) ***Pain Killers:*** Painkillers (analgesic) reduce the pain by acting on CNS.
Example: Paracetamol, Aspirin and Panadol etc.

(ii) ***Antibiotics:*** Antibiotics work against bacterial infections. It either kills or inhibits bacterial growth. For example Penicillin, Cephalosporin and Tetracycline etc.

A recent study found that aspirin may be most effective when taken at night, rather than in the morning.

(iii) ***Vaccine:*** The vaccine is vital for one's life; the vaccine prevents the living body from microbial diseases by developing immunity in the body.
For example hepatitis vaccine, rabies vaccine, covid-19 vaccine etc.

(iv) ***Sedatives:*** Sedative drugs help treat anxiety and sleep problems such as Diazepam (Valium), Alprazolam (Xanax), and Clonazepam (Klonopin)

Danger Zone

1. An allergic reaction could happen with any drug. That can range from itching and rash to a life-threatening anaphylactic reaction.
2. Over dose of pain killers and sedatives can make the person addictive which on leaving causes severe risk factors.
3. You cannot "catch" the disease from the vaccine. Some vaccines contain "inactive" viruses, and it is impossible to get the disease from them. Others have active but weakened viruses designed to prevent the disease.
4. A new study shows that children given antibiotics for routine upper respiratory infections are more susceptible to aggressive antibiotic-resistant strains of the bacteria.
5. Aggressive antibiotics, while helpful if you have a serious infection, can wipe out many useful gut bacteria.

Q.7 Describe the discovery of antiseptics.
OR Who is called as "Father of Antiseptic Surgery"?

Ans: ***Discovery of Antiseptic:*** Joseph Lister is called as "Father of Antiseptic Surgery". Joseph Lister's

contributions paved the way to safer medical procedures. His introduction of the antiseptic process dramatically decreased deaths from childbirth and surgery.

He used carbolic acid as a disinfectant; he used it for washing hands and instruments. He also designed his spray machine with carbolic acid to kill the airborne germs.

Q.8 Who discovered antibiotics and how?

Ans: Sir Alexander Fleming, a Scottish researcher, is credited with the discovery of penicillin in 1928. At the time, Fleming was experimenting with the influenza virus in the Laboratory of the Inoculation Department at St. Mary's Hospital in London.

Often described as a careless lab technician, Fleming returned from a two-week vacation to find that a mold had developed on an accidentally contaminated staphylococcus culture plate. Upon examination of the mold, he noticed that the culture prevented the growth of staphylococci. And this accident led to the discovery of an antibiotic named Penicillin.

Q.9 Define antiseptics.

Ans: ***Antiseptics:*** Antiseptics are antimicrobial substances that are applied to living tissue/skin to prevent microbial infection.

Q.10 Define addictive drugs and describe their major categories.

Ans: ***Addictive Drugs:*** Addictive drugs act on the pleasure centre in the brain, causing a shortcut to reward that, when repeated, can change the way person processes information. Drug addictive qualities may be enhanced by how good they make a person feel when using them and how bad they may make users feel when they wear off.

Following are the major categories of addictive drugs:

(i) ***Sedatives:*** Sedatives are central nervous system (CNS) depressants, a category of drugs that slow normal brain function. One of the most marked effects of sedatives is their potential for abuse and addiction. It can cause drowsiness and sleepiness and are used to reduce anxiety. They also reduce heart rate and breathing and can reduce them to the point that death occurs, if there is an overdose.

(ii) ***Narcotics:*** Narcotics are also called painkillers. These drugs bind with the pain receptor present in CNS and reduce the pain. They are used to treat moderate to severe pain that may not respond well to other pain medications. The short-term effects of opiate use can include feelings of euphoria, pain relief, drowsiness and sedation. Narcotics can be dangerous not only because of their potential for abuse and addiction but also because they can sometimes lead to overdose and death.

(a) ***Heroine:*** Heroin is considered highly addictive. Heroin and other opiold drugs interact with dopamine levels in the brain, which is what causes the burst of pleasure associated with their use. Abuse of heroin can quickly lead to drug tolerance, dependence, and addiction.

(b) ***Morphine:*** Being a narcotic drug, morphine is used to relieve moderate to severe pain. It remains active in the bloodstream for up to 6 Hrs. It acts on the CNS and causes relief from pain but overdose can cause many side effects including nausea, vomiting, constipation, lightheadedness, dizziness, drowsiness, or sweating.

(c) ***Hallucinogen:*** Hallucinogens are a class of drugs that cause hallucinations-profound distortions in a person's perceptions of reality. Some of the typical effects of hallucinogens are increased breathing rate, increased heart rate and blood pressure, irregular heartbeat, palpitations and blurred vision etc.

(iii) ***Marijuana:*** Marijuana is the most commonly used illicit drug in the United States. It can be obtained from the flower, stem and leaves of the Cannabis indicia plant. People smoke marijuana in hand-rolled cigarettes or pipes or water pipes. The intake of this drug produces immediate sensations-increased heart rate, reduce coordination and balance, and a "dreamy," unreal state of mind. Marijuana also affects brain development. When people begin using marijuana as teenagers, the drug may impair thinking, memory, and learning functions and affect how the brain builds connections between the areas necessary for these functions.

Q.11 What are the symptoms of addiction?

Ans: ***Symptoms of Addiction:*** When a person is addicted to a substance, such as a drug, alcohol or nicotine, they are not able to control the use of that substance.
When body levels of that substance go below a certain level the patient has physical and mood related symptoms. There are cravings for drugs, bouts of moodiness, bad temper, poor focus, a feeling of being depressed and empty, frustration, anger, bitterness and resentment. While under the influence of some substances the addict may engage in risky activities, such as fast driving.

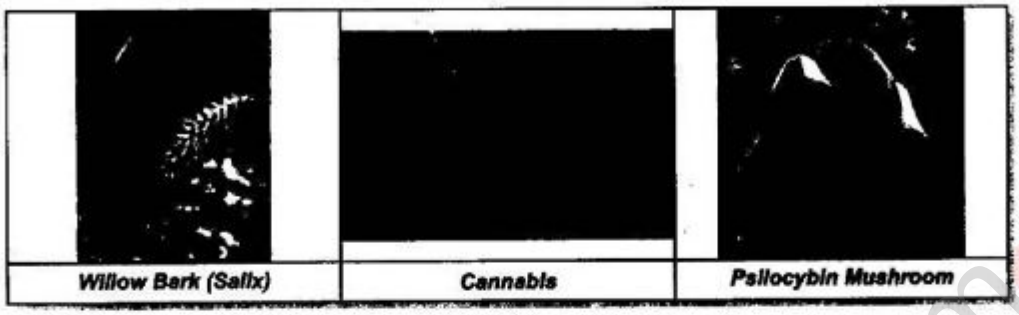
Q.12 Describe problems associated with drug addiction.

Ans: ***Problems Associated with Drug Addiction:*** The problems associated with drug abuse extend beyond immediate personal impact. People being addicted suffer from health issues which increases other illnesses. Addiction can damage one's social life. Research reveals that addictive people can easily involve in crimes such as robbery, stealing/ snatching, a law violator and a criminal. Addiction can damage one's social life. It can also affect their family, when the addict does not get his need he becomes, angry, aggressive, harsh, short temper and does not behave well, ultimately losing relations.

Q.13 List some hallucinogens and narcotics obtaining plants found in Pakistan.

Ans: ***Hallucinogen and Narcotics Obtaining Plants Found in Pakistan.***

Salvia Divinorum | Datura | Opium Poppy



Q.14 [illegible]

Ans: ***Antibiotics:*** Antibiotics are chemical substances mostly used to fight infections caused by bacteria. They treat infections by killing or decreasing the growth of bacteria. These can be produced naturally by microorganisms (bacteria or fungi) or can be derived by microorganisms in a laboratory or can be synthesized in labs.

Antibiotics are used to treat only bacterial infections. They can treat viral or fungal infections. Some of the Antibiotics are Bacteriostatic which means they inhibit the growth of bacteria whereas some antibiotics are bactericidal which means these can kill the bacterial cell.

> The first beta-lactam antibiotic, penicillin was discovered by Alexander Fleming accidentally by mold.

Q.15 [illegible]

Ans: ***Misuse of Antibiotics:*** Antibiotics can cause side effects based on how they work. Antibiotics are prescribed for a particular infection but can harm your normal flora which is beneficial for your body. Apart from it, side effects can also occur which are:

(i) Antibiotic resistance (ii) Diarrhea (iii) Upset stomach
(iv) Thrush, which is a fungal infection that can affect the mouth or digestive tract
(v) Vaginal yeast infection caused by Candida albicans (discharge, burning, pain, itchiness)
(vi) Can cause yellowing of teeth.

Q.16 [illegible]

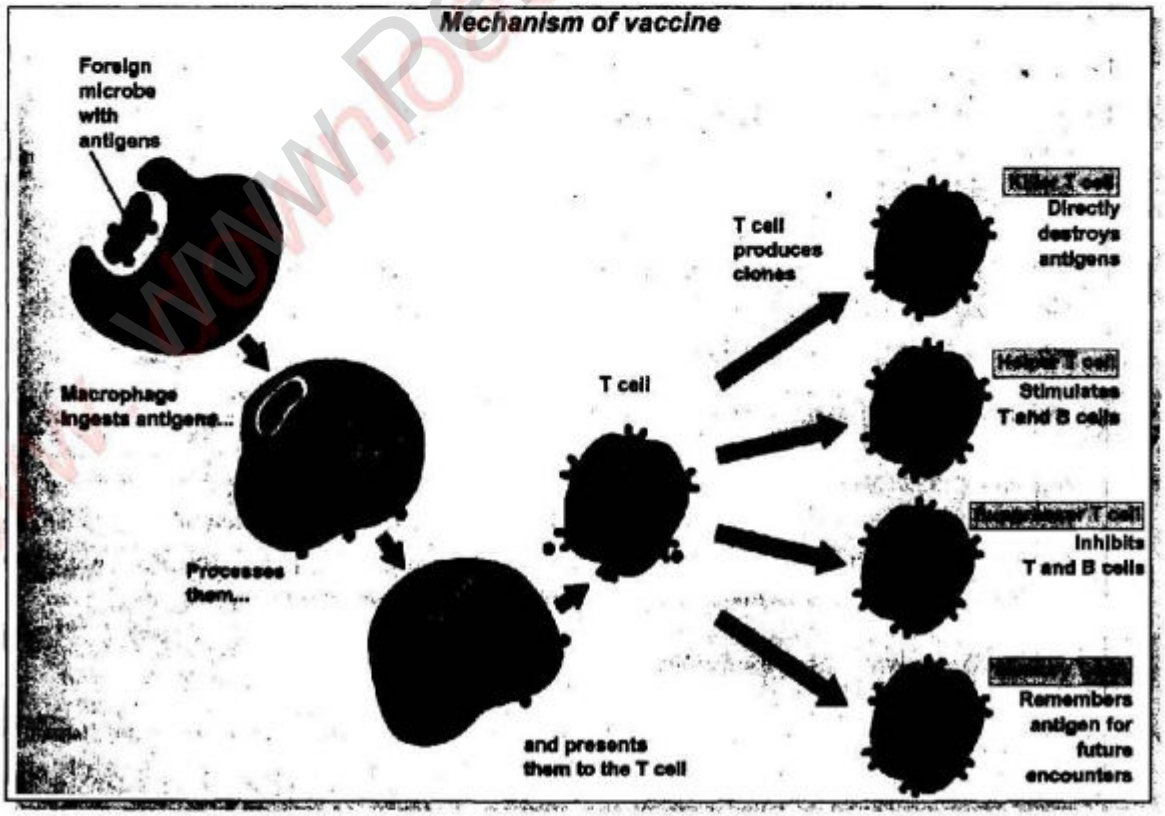
Ans: ***Antibiotic Resistance:*** Overuse of antibiotics can cause antibiotic resistance In which bacteria become habitual for that antibiotics or alter strategy to hinder the effect of antibiotics. The change either protects the bacterium from the action of the medication or neutralizes the medication. They can acquire resistance by getting a resistance gene encoded to their chromosomes.

Q.17 [illegible]

Ans: ***Vaccine:*** A vaccine is a biological preparation that improves immunity to a particular disease. A vaccine typically contains an agent that resembles a disease-causing microorganism and is often made from weakened or killed form of the microbe, its toxins or one of its surface proteins. A

vaccine can confer active immunity against a specific harmful agent by stimulating the immune system to attack the agent. The first vaccine was introduced by British physician Edward Jenner, who in 1796 used the cowpox virus (vaccine) to confer protection against smallpox, a related virus, in humans.

Edward Jenner



Q.18 Define Immunization.

Ans: ***Immunization:*** Immunization is the process whereby a person is made immune or resistant to an infectious disease, typically by the administration of a vaccine.

Q.19 Why antibiotics are not effective against viral infection?

Ans: Antibiotics are used to treat infections caused by bacteria. Two types of antibiotics work to stop bacterial infections. Some slow down the growth of bacteria and damage their ability to reproduce and spread, while others kill the bacteria by destroying the bacteria cell walls. The choice of antibiotic depends on the type of bacteria.

Viruses are different to bacteria; they have a different structure and a different way of surviving. Viruses don't have cell walls that can be attacked by antibiotics; instead, they are surrounded by a protective protein coat.

Unlike bacteria, which attack our body's cells from the outside, viruses move into, live in and make copies of themselves in our body's cells. Viruses can't reproduce on their own as bacteria do, instead, they attach themselves to healthy cells and reprogram those cells to make new viruses. It is because of all of these differences that antibiotics don't work on viruses.

Q.20 Why the sedative is used for?

Ans: Sedatives are a type of prescription medication that slows down your brain activity. They're typically used to make you feel more relaxed. Doctors commonly prescribe sedatives to treat conditions like anxiety and sleep disorders.

Q.21 Why addiction is considered a harmful condition?

Ans: Addiction is considered a harmful condition because it is associated with a wide range of short- and long-term health effects. They can vary depending on the type of drug, how much and how often it's taken and the person's general health. Overall, the effects of drug abuse and dependence can be far reaching. They can impact almost every organ in the human body.

Side effects of drug addiction may include:

(i) A weakened immune system, increasing the risk of illness and infection
(ii) Heart conditions range from abnormal heart rates to heart attacks and collapsed veins and blood vessel infections from injected drugs.
(iii) Nausea and abdominal pain, which can also lead to changes in appetite and weight loss.
(iv) Increased strain on the liver, which puts the person at risk of significant liver damage or liver failure.
(v) Seizures, stroke, mental confusion and brain damage
(vi) Lung disease
(vii) Problems with memory, attention and decision-making, which make daily living more difficult
(viii) Global effects of drugs on the body, such as breast development in men and increases in body temperature, which can lead to other health problems

The most severe health consequence of drug abuse is death.

Q.22 Is it possible to get drugs from animals? Name some of them.

Ans: The healing of human ailments by using therapeutics based on medicines obtained from animals or ultimately derived from them is known as zootherapy.

Many important drugs are derived from animal sources. In most instances, these medicinal substances are derived from the animal's body secretions, fluid or glands. Insulin, heparin,

adrenaline, thyroxin, cod liver oil, musk, beeswax, enzymes, and antitoxins sera are some examples of drugs obtained from animal sources. Like plant products, drugs from animal sources may be crude (unrefined) or refined material.

Numerous drugs are already available on pharmaceutical shelves: Enexatide, derived from the saliva of the Gila monster, prescribed for type two diabetes; Ziconitide, extracted from cone snail venom, for chronic pain; Eptifibatide, a synthetic modelled on the venom of the southern pygmy rattlesnake, administered to prevent heart attacks; Batroxobin, extracted from South American pit vipers and used in several different blood treatments, including the appropriately named "Reptilase"; and Captopril, the first pharmaceutical derived from an animal, an anti-hypertensive approved by the US's Food and Drug Administration (FDA) in 1981.

Q.23 How do bacteria produce antibiotic resistance?

Ans: Antibiotics save lives but any time antibiotics are used, they can cause side effects and lead to antibiotic resistance. Since the 1940s, antibiotics have greatly reduced illness and death from infectious diseases. However, as we use the drugs, germs develop defence strategies against them. This makes the drugs less effective.

How Germs Become Resistant and Spread:

(i) Germs (bacteria and fungi) are everywhere. Some help us. Some make people, crops, or animals sick. Some of those germs are resistant to antibiotics.

(ii) Antibiotics kill germs that cause infections. But antibiotic-resistant germs find ways to survive. Antibiotics also kill good bacteria that protect the body from infection.

(iii) Antibiotic-resistant germs can multiply. Some resistant germs can also give their resistance directly to other germs.

(iv) Once antibiotic resistance emerges, it can spread into new settings and between countries.

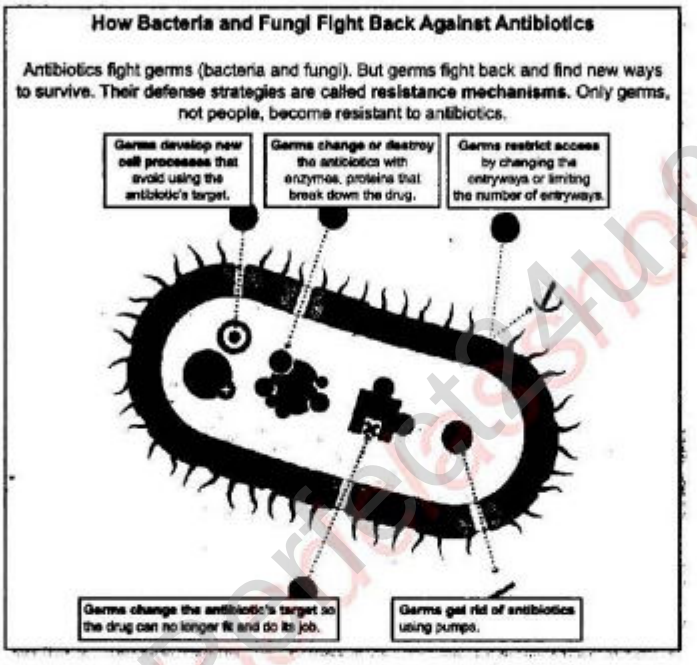
Germ Defense Strategies: Antibiotics fight germs (bacteria and fungi). But germs fight back and find new ways to survive. Their defence strategies are called resistance mechanisms. Bacteria develop resistance mechanisms by using instructions provided by their DNA. Often, resistance genes are found within plasmids, small pieces of DNA that carry genetic instructions from one germ to another. This means that some bacteria can share their DNA and make other germs resistant.

Examples of Defense Strategies for Germs

Germs can use defence strategies to resist the effects of antibiotics. Here are a few examples.

Resistance Mechanisms (Defense Strategies)	*Description*
Restrict access of the antibiotic	Germs restrict access by changing the entryways or limiting the number of entryways. **Example:** Gram-negative bacteria have an outer layer (membrane) that protects them from their environment. These bacteria can use this membrane to selectively keep antibiotic drugs from entering.
Get rid of the antibiotic	Germs get rid of antibiotics using pumps in their cell walls to remove antibiotic drugs that enter the cell. **Example:** Some Pseudomonas aeruginosa bacteria can produce pumps to get rid of several different important antibiotic drugs, including fluoroquinolones, beta-lactams, chloramphenicol, and trimethoprim.
Change or destroy the antibiotic	Germs change or destroy the antibiotics with enzymes, proteins that break down the drug. Example: Klebsiella pneumoniae bacteria produce enzymes called carbapenemases, which break down carbapenem drugs and most other beta-lactam drugs

Bypass the effects of the antibiotic	Germs develop new cell processes that avoid using the antibiotic's target. **Example:** Some Staphylococcus aureus bacteria can bypass the drug effects of trimethoprim
Change the targets for the antibiotic	Many antibiotic drugs are designed to single out and destroy specific parts (or targets) of a bacterium. Germs change the antibiotic's target so the drug can no longer fit and do its job. **Example:** Escherichia coli bacteria with the mcr-1 gene can add a compound to the outside of the cell wall so that the drug colistin cannot latch onto it.



Q.24 [illegible] the mode of vaccination.

Ans: The immune system is a network of cells, tissues and organs that work together to help fight off infection from harmful bacteria or viruses. When a disease-causing agent, such as a virus or bacteria, invades our body, our immune system recognizes it as harmful and will trigger a response to destroy it.

One of the ways our immune system fights off infection is by creating large proteins known as antibodies. These antibodies act as scouts, hunting down the infectious agent, and marking it for destruction by the immune system. Each antibody is specific to the bacteria or virus that it has detected and will trigger a specific immune response. These specific antibodies will remain in the immune system after the infection has gone. This means that if the same disease is encountered again, our immune system has a 'memory' of the disease and is ready to quickly destroy it before we get sick and any symptoms can develop.

Sometimes, however, the immune system doesn't always win this initial battle against the harmful bacteria or virus and we can become very ill or – in extreme cases – die. Vaccination is the safest and most common way to gain immunity against a bacteria or virus that our body has yet to encounter.

Vaccines contain a harmless form of the bacteria or virus that causes the disease we are being immunized against. The bacteria or virus will be killed, greatly weakened, or broken down into small parts before use in the vaccine so that they can trigger an immune response without making us sick. Our immune system will still attack the harmless form of bacteria or virus from the vaccine and will produce antibodies to fight it off. The immune system then keeps a memory of the disease, so if a vaccinated person encounters the disease years later, their immune system is ready to fight it off and prevent an infection from developing.

Summary

- Pharmacology is the branch of biomedical science that is concerned with the use, effect and mode of actions of drugs.
- A drug is a chemical substance that is used to treat, cure, prevent disease and used for artificial pleasure.
- Drugs can be derived from plants and animals.
- There are two categories of drugs
  i. Pharmaceutical or medicinal drug ii. Addictive drugs or narcotics
- Medicinal drugs are derived from microorganisms, minerals, plants, animals or synthetic.
- Medicinal drugs may be pain killers, antibiotics, vaccines, sedatives, antiseptics.
- Addictive drugs may be sedatives, narcotics (Heroin, Morphine, Marijuana).
- Antibiotics are bacteriostatic or bactericidal.
- Bacteriostatic means inhibit the growth of bacteria.
- Bactiocidial means killing the bacteria.
- Antibiotics work against a wide range of Gram+ve and Gram-ve bacteria called broad-spectrum antibiotics.
- A vaccine is a biological preparation that improves immunity to a particular disease.
- Immunization is the process whereby s person is made resistant to an infectious disease.

Textbook Exercise with Solution

A Multiple Choice Questions

Choose the correct answer:

See "Multiple Choice Questions (M.C.Qs)" – Q.1 to 07

B Short Questions

(i) Why antibiotics are not effective against viral infection?

Ans: See 'Short & Detailed Answer Questions' – Q.19

(ii) Why the sedative is used for?

Ans: See 'Short & Detailed Answer Questions' – Q.20

(iii) Why addiction is considered a harmful condition?

Ans: See 'Short & Detailed Answer Questions' – Q.21

(iv) How drugs (medicine) can be taken from a natural source?

Ans: See 'Short & Detailed Answer Questions' – Q.5

(v) Is it possible to get drugs from animals name some of them?

Ans: See 'Short & Detailed Answer Questions' – Q.22

(vi) Do we have any harm with an antibiotic? If, so mention them.

Ans: See 'Short & Detailed Answer Questions' – Q.15

(vii) How do vaccines work against pathogens? Explain the process with the help of a diagram.

Ans: See 'Short & Detailed Answer Questions' – Q.17

C Extensive Response Questions

(i) How do bacteria produce antibiotic resistance?

Ans: See 'Short & Detailed Answer Questions' – Q.23

(ii) Describe the mode of vaccination.

Ans: See 'Short & Detailed Answer Questions' – Q.24