

CHEMISTRY IN EVERYDAY LIFE

CHAPTER 16

Drugs:

Drugs are chemical substances with relatively low molecular masses, typically ranging from about 100 to 500 atomic mass units (u). They play a crucial role in medicine by interacting with specific macromolecular targets in the body to produce a therapeutic or biological response. These targets can include proteins, enzymes, receptors, and nucleic acids.

Chemotherapy: Chemotherapy refers to the treatment of diseases, particularly cancer, using chemical compounds in the form of medicines. The goal is to selectively destroy or inhibit the growth of cancerous cells while minimizing harm to healthy cells.

Classification of Drugs

Drugs are classified based on various criteria:

- **Pharmacological Effects:** This classification considers the therapeutic effects and functions of drugs. For example, drugs can be categorized as analgesics (pain relievers), antibiotics (anti-microbial agents), or antipyretics (fever reducers), based on their pharmacological effects.
- **Drug Action:** Drugs can be categorized by how they exert their effects. Some drugs may act as agonists, mimicking the action of natural molecules in the body, while others act as antagonists, blocking certain biochemical pathways.
- **Chemical Structure:** This classification groups drugs based on their chemical composition and structure. For instance, drugs like penicillin belong to the beta-lactam class due to their shared chemical structure.
- **Molecular Targets:** Drugs can also be classified based on their specific molecular targets in the body. This includes drugs that target enzymes, receptors, or other macromolecules critical for biological functions.

Drug-Target Interaction: Understanding how drugs interact with their molecular targets is essential for designing effective medications. Here are some key points:

- **Drug Transport:** Before reaching their intended targets, drugs must navigate through the body's various systems. Designing drugs that can reach their targets without being metabolized along the way is crucial.
- **Enzyme Functions:** Enzymes play pivotal roles in drug metabolism. They hold substrates for chemical reactions and provide functional groups that can attack these substrates. Inhibitors, such as competitive inhibitors, may compete with natural substrates for attachment to the active site of enzymes.
- **Allosteric Sites:** Some drugs don't bind to the active site of enzymes but instead target allosteric sites. This interaction can alter the shape of the enzyme's active site to such an extent that natural substrates can't recognize it.

Therapeutic Actions of Different Classes of Drugs

Various classes of drugs serve distinct therapeutic purposes:

- **Antacids:** These drugs neutralize excess stomach acid, helping maintain the stomach's pH at an appropriate level. Common antacids include sodium hydrogen carbonate and aluminum and magnesium hydroxides.
- **Tranquilizers:** Used for treating stress and various mental disorders. They can range from mild tranquilizers like chlordiazepoxide to medications like Equanil used for depression and hypertension control.
- **Barbiturates:** Derivatives of barbituric acid, these compounds are used as hypnotics to induce sleep. Examples include veronal, amytal, and nembutal.
- **Analgesics:** These drugs alleviate pain without causing mental impairment or nervous system disturbances. Aspirin and paracetamol fall into the category of non-narcotic or non-habit-forming analgesics, while narcotics like morphine are habit-forming.
- **Antipyretics:** Drugs like aspirin and paracetamol are used to reduce body temperature during high fever.
- **Antibiotics:** These substances inhibit the growth or destroy microorganisms by interfering with their metabolic processes. Penicillin is a narrow-spectrum antibiotic, while ampicillin and amoxycillin are broad-spectrum variants. Chloramphenicol is another broad-spectrum antibiotic used to treat various infections.

- **Antiseptics:** These chemicals inhibit microbial growth or kill microorganisms but are safe for use on living human tissues. Examples include Dettol, bithionol, and iodine-based antiseptics.
- **Disinfectants:** Disinfectants serve a similar purpose to antiseptics but are applied to inanimate objects rather than living tissues. Phenol solutions can function as antiseptics or disinfectants depending on their concentration.
- **Anti-fertility Drugs:** Birth control pills contain synthetic estrogen and progesterone derivatives, such as ethynyl estradiol and norethindrone, to control birth rates.

Artificial Sweetening Agents: Artificial sweeteners are used as sugar substitutes, providing sweetness without the caloric content of sugar. Two examples include:

- **Aspartame:** Aspartame is a methyl ester of a dipeptide formed from aspartic acid and phenylalanine. It's commonly used in cold foods and soft drinks due to its instability at cooking temperatures.
- **Alitame:** Alitame is a high-potency sweetener, making it challenging to control sweetness levels in food products. However, it is more stable than aspartame.

Antioxidants: Antioxidants are substances that slow down the oxidative decomposition of food caused by exposure to oxygen. Two common antioxidants are BHT (butylated hydroxytoluene) and BHA (butylated hydroxy anisole).

Cleansing Agents: Cleansing agents play a crucial role in personal hygiene and cleaning. They can be categorized into two main types:

- **Soaps:** Soaps are typically sodium or potassium salts of long-chain fatty acids. They come in various forms, including toilet soap, medicated soaps, and soap chips.
- **Synthetic Detergents:** Synthetic detergents function similarly to soaps but may not contain traditional soap components. They can be used effectively in both soft and hard water and are classified into several types, including anionic, cationic, non-ionic, biodegradable, and non-biodegradable detergents.
- **Anionic Detergents:** These detergents are sodium salts of sulphonated long-chain alcohols or hydrocarbons. Sodium lauryl sulphate and sodium dodecyl benzene sulphonate are examples.
- **Cationic Detergents:** Cationic detergents consist of quaternary ammonium salts of amines with anions like acetates, chlorides, or bromides. They are used in products like hair conditioners.

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- **Non-ionic Detergents:** Non-ionic detergents lack ions in their constitution and are often esters of high molecular mass alcohols. They are versatile and used in various cleaning products.
 - **Biodegradable Detergents** These detergents can be decomposed by microorganisms present in water. They have straight hydrocarbon chains in their molecules and include sodium lauryl sulphate and sodium dodecyl benzene sulphate.
 - **Non-Biodegradable Detergents:** These detergents are not easily degraded by microorganisms. They often have highly branched hydrocarbon chains, making them less susceptible to bacterial breakdown.

- **Antacids** : Substances that neutralize the excess HCl and raise pH in stomach (Ranitidine, Cimetidine).
- **Antihistamines** : Interfere with natural action of histamine by competing with histamine for binding sites of receptor where histamine exerts its effect.
- **Neurologically Active Drugs**

- Tranquilizers** : Class of chemical compounds used for the treatment of stress and mild or even severe mental diseases. (Ipromiazid, Phenelzine)
- Analgesics** : Reduce/abolish pain without causing impairment of consciousness, mental confusion, incoordination or paralysis or other disturbances of nervous system. These are classified as:
 - Non-narcotic (non-addictive) : (Aspirin, Paracetamol)
 - Narcotic : (Morphine)

- **Antimicrobials**

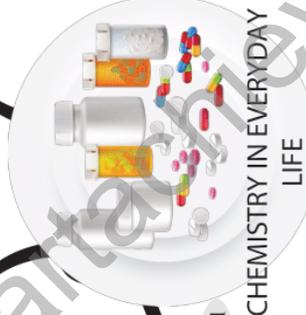
- Antibiotics** : Drugs to treat infections because of their low toxicity for humans and animals. (Prontosil)
 - Antiseptics and Disinfectants** : Chemicals which either kill or prevent the growth of microorganisms. Antiseptics are applied to living tissues whereas disinfectants are applied to inanimate objects.
- **Antifertility Drugs** : Birth control pills. (Norethindrone, ethynylestradiol)

Purpose:

- For their preservation.
 - Enhancing their appeal.
 - Adding nutritive value.
- Artificial Sweetening Agents** : Natural sweeteners (sucrose), artificial sweeteners (Aspartame, Saccharin)
 - Food Preservatives** : Prevent spoilage of food due to microbial growth. (Table salt, sugar)

Medicines: Chemicals which generate therapeutic and useful biological response

Therapeutic Action of Different Classes of Drugs



Chemicals In Food

CHEMISTRY IN EVERYDAY LIFE

Cleansing Agents

Detergents Types

(i) Soap (Saponification)



(ii) Synthetic Detergents :

- **Anionic detergents** : Sodium salts of sulphonated long chain alcohols or hydrocarbons. (Sodium salts of alkyl benzene sulphonates)
- **Cationic detergents** : Quaternary ammonium salts of amines with acetates, chlorides or bromides as anions. (Cetyltrimethylammonium bromide)
- **Non-ionic Detergents** : Non-ionic type.

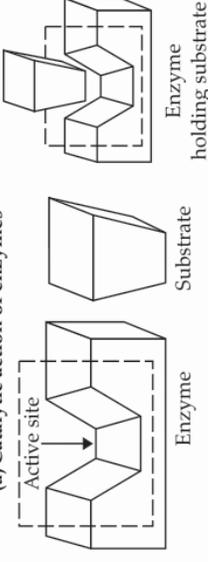
- Drugs are chemicals of low molecular masses. Interact with macromolecular targets to produce a biological response.
- **Classification of drugs:**

- On the basis of pharmacological effect** : Provides range of drugs available for a particular type of problem. (Analgesics, Antiseptics).
- On the basis of drug action** : (Antihistamines inhibit action of histamine responsible for causing inflammation in the body.
- On the basis of chemical structure** : Common structural features. (Sulphonamides)
- On the basis of molecular targets** : Most useful.

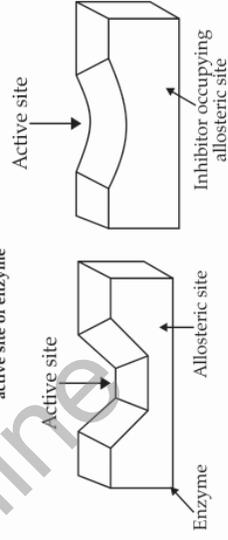
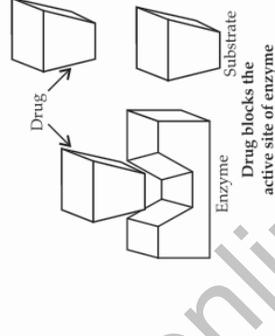
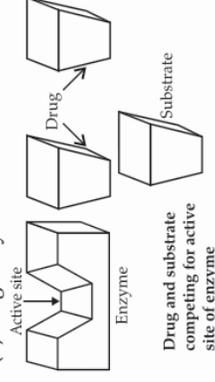
- **Drugs-Target Interaction:**

- Enzymes as Drug Targets**

(a) Catalytic action of enzymes



(b) Drug-enzyme interaction



- Receptors as Drug Targets:** Receptors are proteins crucial for body's communication and are embedded in cell membrane.

Trace the Mind Map

- First Level
- Second Level
- Third Level

PRACTICE QUESTIONS

1. What is the primary interaction target of drugs to produce a biological response?
 - (a) Micromolecular targets
 - (b) Macromolecular targets
 - (c) Any type of molecules
 - (d) Both macromolecules and macromolecules
2. What is the term for the use of chemicals in medicines to achieve a therapeutic effect?
 - (a) Physiotherapy
 - (b) Radiotherapy
 - (c) Chemotherapy
 - (d) Endotherapy
3. Drugs can be categorized based on which of the following criteria?
 - (a) Pharmacological effect
 - (b) Molecular target
 - (c) Chemical structure
 - (d) All of the above
4. What is one of the functions of enzymes?
 - (a) Holding the substrate for a chemical reaction
 - (b) Providing functional groups
 - (c) Both (a) and (b)
 - (d) None of the above
5. What is the term for the site, other than the active site, where a drug binds to an enzyme?
 - (a) Activator site
 - (b) Regular site
 - (c) Allosteric site
 - (d) All of these

6. In which part of the cell are receptor proteins embedded?
- (a) DNA (b) Cell membrane
(c) Cytoplasm (d) RNA
7. Why are receptors considered selective in nature?
- (a) They bind to all types of chemical messengers.
(b) They bind to a specific type of chemical messenger.
(c) They are part of the cell membrane.
(d) All of the above
8. What is one of the functions of an antagonist drug?
- (a) Mimicking the natural messenger
(b) Mimicking the receptor
(c) Binding to the receptor site and inhibiting its function
(d) All of the above
9. In the stomach, what does histamine stimulate the secretion of besides pepsin?
- (a) Sulphuric acid and hydrochloric acid
(b) Sulphuric acid
(c) Hydrochloric acid
(d) Sodium hydroxide
10. What category does noradrenaline belong to?
- (a) Antidepressant (b) Antihistamine
(c) Neurotransmitter (d) Antacid
11. Iproniazid and phenelzine fall under which class of drugs?
- (a) Depressant drugs (b) Antidepressant drugs
(c) Antibiotics (d) Antiseptic

12. Which drug is used to control both depression and hypertension?

- (a) Penicillin (b) Tetracycline
(c) Salvarsan (d) Equanil

13. What are some derivatives of barbituric acid?

- (a) Veronal and amytal
(b) Nembutal and luminal
(c) Both (a) and (b)
(d) Neither (a) nor (b)

14. What is the IUPAC name for aspirin?

- (a) o-acetyl salicylic acid (b) phenyl salicylate
(c) acetyl salicylate (d) methyl salicylic acid

15. Which drug inhibits the synthesis of prostaglandins?

- (a) Paracetamol (b) Aspirin
(c) Codeine (d) Valium

16. Which analgesics are referred to as opiates?

- (a) Morphine and codeine (b) Both (a) and (b)
(c) Aspirin (d) Neither (a) nor (b)

17. Which of the following is an arsenic-containing drug?

- (a) Penicillin (b) Equanil
(c) Salvarsan (d) Chloramphenicol

18. Among the options, which antibiotic is considered narrow spectrum?

- (a) Ampicillin (b) Amoxicillin
(c) Chloramphenicol (d) Penicillin G

19. Which antibiotic is known to be toxic toward certain strains of cancer cells?

- (a) Vancomycin (b) Dysidazirine
(c) Ofloxacin (d) Penicillin G

20. What is an example of a synthetic progesterone derivative?

- (a) Novestrol (b) Chloroxylenol
(c) Norethindrone (d) Terpeneol

21. Which artificial sweetener remains stable only under cold conditions?

- (a) Saccharin (b) Sucralose
(c) Aspartame (d) Alitame

22. What is the most commonly used food preservative to prevent spoilage due to microbial growth?

- (a) CH_3COONa (b) Table salt
(c) Vegetable oils (d) All of the above

23. In a chemical reaction involving $2\text{C}_2\text{H}_3\text{COONa} + \text{CaCl}_2 \rightarrow \dots$, what product is formed?

- (a) $(\text{C}_2\text{H}_3\text{COO})_2\text{Ca}$; insoluble calcium stearate
(b) $(\text{C}_2\text{H}_3\text{COO})_2\text{Ca}$; soluble calcium stearate
(c) $(\text{C}_2\text{H}_3\text{COO})_2\text{Ca}$; soluble calcium stearate
(d) $(\text{C}_2\text{H}_3\text{COO})_2\text{Ca}$; insoluble calcium stearate

24. Which of the following is an example of an anionic detergent?

- (a) Sodium lauryl sulphate
- (b) Cetyltrimethylammonium bromide
- (c) Glyceryl oleate
- (d) Sodium stearate

25. What type of detergent is formed when stearic acid reacts with polyethylene glycol?

- (a) Cationic detergents
- (b) Non-ionic detergents
- (c) Anionic detergents
- (d) None of the above

26. Which of the following is a synthetic polymer used in making non-stick cookware and as a lubricant?

- (a) PVC
- (b) Teflon
- (c) Polyethylene
- (d) Bakelite

27. Antacids work by:

- (a) Increasing stomach acidity
- (b) Reducing stomach acidity
- (c) Increasing the production of gastric acid
- (d) Inhibiting enzyme activity in the stomach

28. Which type of drug is used to reduce fever and relieve pain but does not cause impairment of consciousness?

- (a) Analgesic
- (b) Antibiotic
- (c) Antiseptic
- (d) Antacid

29. What is the common name for acetylsalicylic acid, a widely used analgesic and anti-inflammatory drug?

- (a) Aspartame
- (b) Paracetamol
- (c) Aspirin
- (d) Codeine

30. Which of the following is a narcotic analgesic often used for pain relief?

- (a) Paracetamol (b) Ibuprofen (c) Morphine (d) Antacid

31. Antibiotics that are effective against a broad range of bacteria are known as:

- (a) Narrow-spectrum antibiotics
(b) Synthetic antibiotics
(c) Broad-spectrum antibiotics
(d) Antiseptics

32. What is the function of an antiseptic?

- (a) Inhibit the growth of microorganisms in living tissues
(b) Inhibit the growth of microorganisms on inanimate objects
(c) Reduce fever and pain
(d) Neutralize stomach acid

33. Which of the following is a synthetic sweetening agent often used in sugar-free products?

- (a) Sucrose (b) Saccharin (c) Glucose (d) Fructose

34. What role do antioxidants play in food preservation?

- (a) They increase the rate of oxidation in food
(b) They reduce the speed of decomposition by oxidation
(c) They enhance the flavor of food
(d) They act as artificial sweeteners

35. What is the primary function of soaps and synthetic detergents in cleansing agents?

- (a) They kill microorganisms
(b) They serve as preservatives
(c) They create foam
(d) They remove dirt and grease

HINTS ANS SOLUTIONS

1. (b) Macromolecular targets

- Drugs primarily interact with macromolecular targets, such as enzymes and receptors, to produce biological responses. These interactions are crucial for the therapeutic effects of drugs.

2. (c) Chemotherapy

- Chemotherapy refers to the treatment of diseases using chemicals in the form of medicines. It is commonly used in the context of cancer treatment, where drugs are used to inhibit the growth of cancer cells.

3. (d) All of the above

- Drugs can be classified based on pharmacological effects, drug actions, chemical structures, and molecular targets. Therefore, the correct answer is "All of the above."

4. (c) Both (a) and (b)

- Enzymes serve multiple functions, including holding the substrate for a chemical reaction (a) and providing functional groups that aid in substrate conversion (b).

5. (c) Allosteric site

- The site, apart from the active site, where a drug can bind to an enzyme is called the allosteric site. Binding to this site can alter the enzyme's shape and affect its activity.

6. (b) Cell membrane

- Receptor proteins are typically embedded in the cell membrane and play a crucial role in cell signaling and molecular recognition.

7. (b) A particular type of chemical messenger

- Receptors are selective and bind to specific types of chemical messengers, ensuring precise signaling within the body.

8. (c) It binds to the receptor site and inhibits its function

- Antagonist drugs function by binding to the receptor site and blocking or inhibiting its normal function.

9. (c) Hydrochloric acid

- In the stomach, histamine stimulates the secretion of pepsin and hydrochloric acid, which are essential for the digestion of food.

10. (c) Neurotransmitter

- Noradrenaline is a neurotransmitter that plays a role in transmitting nerve signals in the sympathetic nervous system.

11. (b) Antidepressant drugs

- Iproniazid and phenelzine belong to the class of antidepressant drugs and are used to treat depression and related disorders.

12. (d) Equanil

- Equanil is a drug used for controlling both depression and hypertension, making it a valuable therapeutic option for patients with these conditions.

13. (c) Both (a) and (b)

- Veronal and amytal are examples of derivatives of barbituric acid used as hypnotic agents (sleep-inducing drugs).

14. (a) o-acetyl salicylic acid

- The IUPAC name of aspirin is o-acetyl salicylic acid. Aspirin is a commonly used analgesic and anti-inflammatory drug.

15. (b) Aspirin

- Aspirin inhibits the synthesis of prostaglandins, which are responsible for inflammation and pain. This action contributes to its analgesic and anti-inflammatory effects.

16. (a) Morphine and codeine

- Morphine and codeine are opiates and are classified as narcotics. They are potent analgesics used to relieve severe pain.

17. (c) Salvarsan

- Salvarsan is an arsenic-containing drug that was one of the first effective antibiotics used to treat syphilis.

18. (d) Penicillin G

- Penicillin G is a narrow-spectrum antibiotic effective against a limited range of bacteria, primarily gram-positive ones.

19. (b) Dysidazirine

- Dysidazirine is an antibiotic known to be toxic to certain strains of cancer cells, making it a potential candidate for cancer treatment.

20. (c) Norethindrone

- Norethindrone is an example of a synthetic progesterone derivative used in birth control pills.

21. (c) Aspartame

- Aspartame is an artificial sweetener that is stable under cold conditions and is commonly used in cold foods and soft drinks.

22. (b) Table salt

- Table salt (sodium chloride, NaCl) is a commonly used food preservative that prevents spoilage due to microbial growth.

23. (a) $(C_2H_3COO)_2Ca$; insoluble calcium stearate

- The reaction $2C_2H_3COONa + CaCl_2$ results in the formation of insoluble calcium stearate, represented as $(C_2H_3COO)_2Ca$.

24. (a) Sodium lauryl sulphate

- Sodium lauryl sulphate is an example of an anionic detergent used in various cleaning products.

25. (b) Non-ionic detergents

- When stearic acid reacts with polyethylene glycol, it forms non-ionic detergents, which are known for their versatility and ability to work in both soft and hard water.

26. (b) Teflon

- Explanation: Teflon, also known as polytetrafluoroethylene (PTFE), is a synthetic polymer used in non-stick cookware and as a lubricant due to its low friction properties. PVC (Polyvinyl chloride) is another synthetic polymer used for different purposes.

27. (b) Reducing stomach acidity

- Explanation: Antacids work by reducing stomach acidity. They neutralize excess stomach acid to provide relief from conditions like heartburn and indigestion.

28. (a) Analgesic

- Explanation: Analgesics are drugs used to relieve pain without causing impairment of consciousness. They are not antibiotics, antiseptics, or antacids.

29. (c) Aspirin

- Explanation: Aspirin is the common name for acetylsalicylic acid, a widely used analgesic and anti-inflammatory drug. Aspartame is an artificial sweetener, paracetamol is another analgesic, and codeine is a narcotic analgesic.

30. (c) Morphine

- Explanation: Morphine is a narcotic analgesic often used for pain relief. Paracetamol and ibuprofen are non-narcotic analgesics, while antacids are used to reduce stomach acidity.

31. (c) Broad-spectrum antibiotics

- Explanation: Antibiotics that are effective against a broad range of bacteria are known as broad-spectrum antibiotics. Narrow-spectrum antibiotics are effective against a limited range of bacteria.

32. (a) Inhibit the growth of microorganisms in living tissues

- Explanation: Antiseptics are chemicals that inhibit the growth of microorganisms on or in living tissues but are not harmful to the tissues themselves. They are used for disinfecting wounds and skin surfaces.

33. (b) Saccharin

- Explanation: Saccharin is a synthetic sweetening agent often used in sugar-free products. It is an artificial sweetener and is much sweeter than sucrose (table sugar).

34. (b) They reduce the speed of decomposition by oxidation

- Explanation: Antioxidants retard the action of oxygen on food, reducing the speed of decomposition by oxidation. They help preserve the quality and freshness of food products.

35. (d) They remove dirt and grease

- Explanation: The primary function of soaps and synthetic detergents in cleansing agents is to remove dirt and grease from surfaces. They do so by forming micelles that encapsulate and lift away these substances when in contact with water.