MULTIPLE CHOICE

1. During which phase of drug action is a drug made available to the body?
   a. Administration
   b. Pharmacokinetic
   c. Pharmacodynamic
   d. Pharmacogenetic

   ANS: A
   A drug dose is made available to the body during the drug administration phase. The pharmacokinetic phase involves the time course and disposition of a drug in the body, based on its absorption, distribution, metabolism, and elimination. The pharmacodynamic phase involves the mechanisms of drug action by which a drug molecule causes its effect on the body. Pharmacogenetics is the study of variations among patients in their responses to drugs that are caused by hereditary differences.

   REF: p. 12

2. A drug's portal of entry into the body is known as the
   a. formulation.
   b. dosage.
   c. route of administration.
   d. additive.

   ANS: C
   Formulation involves the physical state of the drug in association with nondrug components (e.g., the vehicle). Dosage involves the amount of active drug being administered. The route of administration is the portal of entry for the drug into the body, such as by oral (enteral) administration, injection, or inhalation. Additives are agents that help deliver the drug. For example, a metered dose inhaler (MDI) uses propellants to move the drug, a dry powder inhaler (DPI) uses bulking agents to improve dispersion of the drug, and capsules use a gelatinous material on the outside to allow the drug to be swallowed more easily.

   REF: p. 12

3. Which of the following are routes of drug administration?
   1. Enteral
   2. Parenteral
   3. Ointment
   4. Inhalation

   a. 1 and 4 only
   b. 1, 2, and 3 only
   c. 1, 2, and 4 only
   d. 1, 2, 3, and 4

   ANS: C

Enteral (gastrointestinally), parenteral (other than gastrointestinally, generally injected), and inhalation are three of the five broad categories of drug administration (the other two are transdermal and topical). *Ointment* describes the formulation of a drug that may be administered topically.

REF: p. 13

4. Which of the following methods of drug delivery are commonly considered parenteral?
   1. Intravenous
   2. Intramuscular
   3. Paste
   4. Aerosol

   a. 1 and 4 only
   b. 1 and 2 only
   c. 3 and 4 only
   d. 1, 2, 3, and 4

   ANS: B
   Technically, the term *parenteral* means "besides the intestine," which implies any route of administration other than enteral. However, the parenteral route is commonly taken to mean injection of a drug. Various options are available for injection of a drug, the most common of which are the following:

   Intravenous (IV): Injected directly into the vein, allowing nearly instantaneous access to the systemic circulation. Drugs can be given as a bolus, in which case the entire dose is given rapidly, leading to a sharp increase in the plasma concentration, or as a steady infusion to avoid this precipitous increase.
   (IM): Injected deep into a skeletal muscle. Because the drug must be absorbed from the muscle into the systemic circulation, the drug effects occur more gradually than with intravenous injection, although typically more rapidly than by the oral route.
   Subcutaneous (SC): Injected into the subcutaneous tissue beneath the epidermis and dermis.
   Intraosseous (IO): Injected into the marrow of the bone.

   REF: p. 13

5. Which of the following methods of drug administration requires a needle?
   1. Transdermal
   2. Inhalation
   3. Subcutaneous
   4. Intravenous

   a. 1 and 3 only
   b. 2 and 4 only
   c. 1 and 2 only
   d. 3 and 4 only

   ANS: D

Subcutaneous administration involves the use of a needle to inject drug into the tissue beneath the epidermis and dermis. Intravenous administration involves the use of a needle to inject drug directly into a vein or via a catheter put in place for this purpose. With transdermal administration, drug is absorbed percutaneously, obviating the need for a hypodermic needle and decreasing the fluctuations in plasma drug levels that can occur with repeated oral administration. Inhalation involves administering the drug in an aerosolized form directly to the lung.

REF: p. 13

6. Which of the following is *not* a part of the pharmacokinetic phase of a drug?
   a. Absorption
   b. Receptor site
   c. Metabolism
   d. Elimination

   ANS: B
   Absorption, distribution, metabolism, and speed and method of elimination are factors that influence the course of a drug after it is introduced in the body. Receptors participate in the pharmacodynamic phase of drug action.

   REF: p. 14

7. The process of incorporating a substance into a cell by engulfment and transport to the cell interior in vesicles is termed
   a. aqueous diffusion.
   b. lipid diffusion.
   c. bioavailability.
   d. pinocytosis.

   ANS: D
   Aqueous diffusion describes the absorption of a substance into the aqueous compartments of the body, such as the interstitial spaces. Lipid diffusion describes the movement of a drug across lipid membranes en route to its place of action. Bioavailability indicates the portion of a drug that reaches the systemic circulation. Pinocytosis describes the incorporation of a substance into a cell by a process of membrane engulfment and transport of the substance to the cell interior in vesicles, allowing translocation across a membrane barrier.

   REF: p. 15

8. Which of the following factors may have an effect on drug absorption?
   1. Route of administration
   2. Metabolic degradation
   3. Inactivation by stomach acids
   4. Blood flow to absorption site
   a. 1 only
   b. 1 and 2 only
   c. 1 and 4 only
   d. 1, 2, 3, and 4

   ANS: D

The route of administration determines which barriers to absorption must be crossed by a drug. Such barriers can affect the drug's time to onset and time to peak effect. Intravenous administration bypasses the need for absorption from the gastrointestinal tract seen with oral administration, generally gives a very rapid onset and peak effect, and provides 100% availability of the drug in the bloodstream. The amount of drug in the bloodstream (its bioavailability) is influenced not only by absorption but also by inactivation caused by stomach acids and by metabolic degradation, which can occur before the drug reaches the main systemic compartment. Another important variable governing absorption and bioavailability is blood flow to the site of absorption.

REF: p. 15

9. Which of the four major body compartments contains the *smallest* average volume in liters?
   a. Intracellular fluid
   b. Vascular space
   c. Interstitial fluid
   d. Fat

   ANS: B
   Intracellular fluid accounts for an average of 20 L of volume. Blood accounts for an average of 5 L of volume. Interstitial fluid accounts for an average of 10 L of volume. Fat accounts for an average of 14 to 25 L of volume.

   REF: p. 16

10. The principal organ for drug metabolism is the
    a. brain.
    b. liver.
    c. stomach.
    d. lung.

    ANS: B
    Other tissues, such as the lung, intestinal wall, and endothelial vascular wall, can transform or metabolize drugs; however, the liver is the principal organ for drug metabolism.

    REF: p. 17

11. Which of the following routes of drug administration help to reduce the *first-pass effect*?
    1. Oral administration
    2. Injection
    3. Sublingual tablets
    4. Rectal administration

    a. 1 and 3 only
    b. 2 and 4 only
    c. 2, 3, and 4 only
    d. 1, 2, and 4 only

    ANS: C

Oral administration allows the drug to travel from the stomach or intestine to the branches of the portal vein, which drain directly into the liver, allowing for a large portion of the drug to be terminated before reaching the systemic circulation. The following routes avoid first-pass circulation through the liver: injection, buccal or sublingual tablets, transdermal (e.g., patch) or rectal (e.g., suppositories) administration, and inhalation. These routes of administration bypass the portal venous circulation of the liver, allowing drugs to be generally distributed in the body before being circulated through the liver and ultimately metabolized. They also bypass metabolic degradation occurring in the gut as a result of specific metabolic enzymes (e.g., cytochrome P450 family 3 [CYP3]) or bacterial flora.

REF: p. 17

12. Which of the following organs is considered the primary site of drug excretion?
    a. Kidney
    b. Liver
    c. Small intestine
    d. Stomach

    ANS: A
    The primary site of drug excretion in the body is the kidney. The liver is the site of much drug metabolism, and the kidney is important for removing drug metabolites produced by the liver. Some drugs are not metabolized and are eliminated from the circulation entirely by the kidney. The small intestine and stomach are potential sites for drug *absorption*.

    REF: p. 17

13. Inhaled aerosols may have which types of intended effects on the body?
    1. Enteral
    2. Local
    3. Systemic
    4. Oral

    a. 1 and 3 only
    b. 2 and 4 only
    c. 2 and 3 only
    d. 1, 2, 3, and 4

    ANS: C
    Enteral and *oral* describe possible routes of drug administration. Inhaled aerosols are deposited on the surface of the upper or lower airway and are a form of topically administered drug. As topically deposited agents, inhaled aerosols can be intended for either a local effect in the upper or lower airway or a systemic effect as the drug is absorbed and distributed in the blood.

    REF: p. 19 | p. 20

14. Approximately what percentage of an inhaled aerosol reaches the lower respiratory tract with current delivery devices?
    a. 0% to 10%
    b. 10% to 30%
    c. 50% to 60%

d. 90% to 100%

ANS: B
Although 10% is the generally accepted amount of drug that actually reaches the lower respiratory tract, this number may range from 10% to 30% based on the delivery device and patient technique.

REF: p. 21

15. Out of the total systemically available drug, the proportion of drug available from the lung is known as the
    a. TI
    b. V_D
    c. L/T ratio
    d. $T_{1/2}$

    ANS: C
    The therapeutic index (TI) is the difference between the minimal therapeutic and toxic concentrations of a drug. The volume of distribution (V_D) is the ratio of the amount of drug administered versus the plasma concentration of the drug. For an aerosol drug (bronchodilator, corticosteroid, mediator antagonist) that targets the respiratory tract, the L/T ratio is defined as the proportion of drug available from the lung out of the total systemically available drug. Plasma half-life ($T_{1/2}$) describes the amount of time required for the plasma concentration of a drug to decrease by one-half.

    REF: p. 21 | p. 22

16. The mechanism of drug action by which a drug molecule causes its effect in the body is known as the
    a. pharmacodynamic phase.
    b. elimination phase.
    c. pharmacokinetic phase.
    d. administration phase.

    ANS: A
    Pharmacokinetics describes what the body does to a drug, and pharmacodynamics describes what the drug does to the body. Elimination describes the removal of a drug from the body; the kidney is the primary site of drug elimination. The pharmacokinetic phase describes the time course and deposition of a drug in the body. The administration phase describes the method by which a drug dose is made available to the body.

    REF: p. 23

17. The relationship between a drug's chemical structure and its clinical activity is known as
    a. bioavailability.
    b. biotransformation.
    c. pharmacokinetics.
    d. structure-activity relationship.

    ANS: D

Bioavailability refers to the amount of a drug that reaches the systemic circulation. Biotransformation is the transformation of a drug into a metabolite or inactive form. Pharmacokinetics describes the time course and disposition of a drug in the body. The relationship between a drug's chemical structure and its clinical effect or outcome on the body is termed the structure-activity relationship (SAR).

REF: p. 23

18. Given the following information, which drug is most potent?

Drug	**ED_{50}**
A	10 mg
B	5 mg
C	1 mg
D	15 mg

a. Drug A
b. Drug B
c. Drug C
d. Drug D

ANS: C
The dose at which 50% of the response to the drug occurs is indicated in Figure 2-13 and is referred to as the ED_{50}, the dose of drug that produces 50% of the maximal effect. This may also be denoted as the EC_{50}, for effective concentration giving 50% of the maximal response. *Potency* refers to the concentration (EC_{50}) or dose (ED_{50}) of a drug producing 50% of that drug's maximal response. The potency of two drugs, A and B, can be compared on the basis of the ED_{50} values of the two drugs: relative potency, A and B = ED_{50} (B)/ED_{50} (A).

REF: p. 27

19. Which of the following drugs has the greatest potential of crossing over from a therapeutic effect to a toxic effect?

Drug	**TI**
A	2
B	20
C	5
D	15

a. Drug A
b. Drug B
c. Drug C
d. Drug D

ANS: A
The ratio of the dose that is toxic to 50% of test subjects (LD_{50}) to the dose that provides relief to 50% of subjects (ED_{50}) is the clinical therapeutic index (TI). This index represents the safety margin of the drug. The smaller the TI, the greater the possibility of crossing from a therapeutic effect to a toxic effect. Drug A has the narrowest TI.

REF: p. 27

20. The drug albuterol binds to its corresponding receptor to initiate its intended response of bronchodilation. By definition, albuterol is known as a(n)
    a. agonist.
    b. antagonist.
    c. both A and B.
    d. neither A nor B.

    ANS: A
    An agonist is a drug or chemical that binds to a corresponding receptor (has affinity) and initiates a cellular effect or response (has efficacy). An antagonist is a drug or chemical that is able to bind to a receptor (has affinity) but causes no response (zero efficacy).

    REF: p. 28

21. Two different drugs (each with its own mechanism of action) are administered to a patient in an attempt to relieve bronchoconstriction. The ordering physician hopes that the effect of the drug pair will be greater than the sum of the separate effects of each individual drug. If successful, this would be an example of
    a. potentiation.
    b. synergism.
    c. additivity.
    d. tolerance.

    ANS: B
    Potentiation is a special case of synergism in which one drug has no effect but can increase the activity of another drug. Synergism occurs when two drugs act on a target organ by different mechanisms of action and the effect of the drug pair is greater than the sum of the separate effects of the drugs. Additivity occurs when two drugs act on the same receptors and the combined effect is the simple linear sum of the effects of the two drugs, up to a maximal effect. Tolerance describes a decreasing intensity of response to a drug over time.

    REF: p. 28

22. Mrs. Johnson is a 37-year-old woman who has been taking medication for lower back pain for the last 18 months. She reports to her physician that although the medication initially rendered her pain-free, she now receives very little relief from her daily dose. This situation is described by which of the following terms used to refer to drug responsiveness (assuming that her condition has not actually worsened)?
    a. Hypersensitivity
    b. Idiosyncratic effect
    c. Tolerance
    d. Tachyphylaxis

    ANS: C
    Hypersensitivity describes an allergic or immune-mediated response to a drug, which can be serious, requiring airway maintenance or ventilatory assistance. An idiosyncratic effect is one that is unusual, opposite to, or has no effect compared with the predicted usual effect in an individual. Tolerance describes a decreasing intensity of response to a drug over time. Tachyphylaxis describes a rapid decrease in response to a drug.

REF: p. 29

23. A perfectly efficient aerosol delivery device would theoretically have an L/T ratio of which of the following?
    a. 0
    b. 0.5
    c. 0.75
    d. 1.0

    ANS: D
    For an aerosol drug that targets the respiratory tract, the L/T ratio can be defined as the proportion of drug available from the lung, out of the total systemically available drug. Theoretically, if a 10-mg dose was administered, and a resulting 10 mg was available systemically, the L/T ratio would be 10 divided by 10, which equals 1.

    REF: p. 21

24. Which of the following factors can increase the lung availability/total systemic availability ratio of inhaled drugs?
    1. Efficient delivery devices
    2. Inhaled drugs with a high first-pass metabolism rate
    3. Mouth washing
    4. Use of a reservoir device

    a. 1 and 2 only
    b. 1 and 3 only
    c. 1, 2, and 3 only
    d. 1, 2, 3, and 4

    ANS: D
    Any action that reduces the swallowed portion of the inhaled drug can increase the L/T ratio; a high first-pass metabolism rate can also increase the L/T ratio.

    REF: p. 21 | p. 22

25. The drug methacholine can stimulate parasympathetic receptors in the airways, causing bronchoconstriction. Epinephrine can stimulate β_2 receptors in the airways, causing bronchodilation. These two opposing effects that cancel each other out are an example of
    a. chemical antagonism.
    b. functional antagonism.
    c. competitive antagonism.
    d. synergism.

    ANS: B
    Chemical antagonism is a direct chemical interaction between a drug and a biologic mediator, which inactivates the drug. Functional antagonism occurs when two drugs each produce an effect and the effects cancel each other out. Competitive antagonism occurs when a drug has an affinity for a receptor but no efficacy and at the same time blocks the active agonist from binding to and stimulating the receptor. Synergism occurs when two drugs act on a target organ by different mechanisms of action and the effect of the drug pair is greater than the sum of the separate effects of the drugs.

REF: p. 28

26. The lining of the lower respiratory tract presents barriers to drug absorption and includes which of the following elements?
    1. Airway surface liquid
    2. Capillary vascular network
    3. Epithelial cells
    4. Interstitium

    a. 1 and 2 only
    b. 1 and 3 only
    c. 1, 2, and 3 only
    d. 1, 2, 3, and 4

    ANS: D
    The lining of the lower respiratory tract presents barriers to drug absorption. This mucosal barrier consists of the following five identifiable elements: airway surface liquid, epithelial cells, basement membrane, interstitium, and capillary vascular network.

    REF: p. 14

27. The study of genetic factors and their influence on drug response is termed
    a. pharmacogenetics.
    b. functional antagonism.
    c. competitive antagonism.
    d. pharmacokinetics.

    ANS: A
    Functional antagonism occurs when two drugs each produce an effect and the effects cancel each other out. Competitive antagonism occurs when a drug has an affinity for a receptor but no efficacy and at the same time blocks the active agonist from binding to and stimulating the receptor. Pharmacokinetics is the time course and disposition of a drug in the body, based on its absorption, distribution, metabolism, and elimination.

    REF: p. 29

28. The difference between the minimal therapeutic and toxic concentrations of a drug is known as the
    a. TI.
    b. V_D.
    c. L/T ratio.
    d. $T_{1/2}$.

    ANS: A

The therapeutic index (TI) is the difference between the minimal therapeutic and toxic concentrations of a drug. The volume of distribution (V_D) is the ratio of the amount of drug administered versus the plasma concentration of the drug. For an aerosol drug (bronchodilator, corticosteroid, mediator antagonist) that targets the respiratory tract, the L/T ratio is defined as the proportion of drug available from the lung out of the total systemically available drug. Plasma half-life ($T_{1/2}$) describes the amount of time required for the plasma concentration of a drug to decrease by one-half.

REF: p. 18

29. A measure of how quickly a drug is eliminated from the body is known as the
    a. TI.
    b. V_D.
    c. L/T ratio.
    d. $T_{1/2}$.

    ANS: D
    The therapeutic index (TI) is the difference between the minimal therapeutic and toxic concentrations of a drug. The volume of distribution (V_D) is the ratio of the amount of drug administered versus the plasma concentration of the drug. For an aerosol drug (bronchodilator, corticosteroid, mediator antagonist) that targets the respiratory tract, the L/T ratio is defined as the proportion of drug available from the lung out of the total systemically available drug. Plasma half-life ($T_{1/2}$) describes the amount of time required for the plasma concentration of a drug to decrease by one-half.

    REF: p. 18

30. Mr. Ashoor is a 29-year-old asthmatic patient who takes MDI albuterol for wheezing and typically gets quick relief following two puffs. After he mowed the lawn today, he realized he was having a rapid decrease in responsiveness to his albuterol. He tried taking it again but still had no relief. This situation is described by which of the following terms used to refer to drug responsiveness?
    a. Hypersensitivity
    b. Idiosyncratic effect
    c. Tolerance
    d. Tachyphylaxis

    ANS: D
    Hypersensitivity describes an allergic or immune-mediated response to a drug, which can be serious, requiring airway maintenance or ventilatory assistance. An idiosyncratic effect is one that is unusual, opposite to, or has no effect compared with the predicted usual effect in an individual. Tolerance describes a decreasing intensity of response to a drug over time. Tachyphylaxis describes a rapid decrease in response to a drug.

    REF: p. 29

31. Which is the term that refers to the concentration (EC_{50}) or dose (ED_{50}) of a drug producing 50% of the maximal response of the drug?
    a. Potency
    b. Hypersensitivity
    c. Potentiation

d. Additivity

ANS: A
Hypersensitivity describes an allergic or immune-mediated response to a drug, which can be serious, requiring airway maintenance or ventilatory assistance. Potency refers to the concentration (EC_{50}) or dose (ED_{50}) of a drug producing 50% of the maximal response of the drug. Additivity occurs when two drugs act on the same receptors and the combined effect is the simple linear sum of the effects of the two drugs, up to a maximal effect. Potentiation is a special case of synergism in which one drug has no effect but can increase the activity of another drug.

REF: p. 27 | p. 28

32. An allergic or immune-mediated reaction to a drug, which can be serious, requiring airway maintenance or ventilatory assistance is called
a. potency.
b. hypersensitivity.
c. potentiation.
d. additivity.

ANS: B
Hypersensitivity describes an allergic or immune-mediated response to a drug, which can be serious, requiring airway maintenance or ventilatory assistance. Potency refers to the concentration (EC_{50}) or dose (ED_{50}) of a drug producing 50% of the maximal response of the drug. Additivity occurs when two drugs act on the same receptors and the combined effect is the simple linear sum of the effects of the two drugs, up to a maximal effect. Potentiation is a special case of synergism in which one drug has no effect but can increase the activity of another drug.

REF: p. 29

33. A special case of synergism in which one drug has no effect but can increase the activity of another drug is known as
a. potency.
b. hypersensitivity.
c. potentiation.
d. additivity.

ANS: C
Hypersensitivity describes an allergic or immune-mediated response to a drug, which can be serious, requiring airway maintenance or ventilatory assistance. Potency refers to the concentration (EC_{50}) or dose (ED_{50}) of a drug producing 50% of the maximal response of the drug. Additivity occurs when two drugs act on the same receptors and the combined effect is the simple linear sum of the effects of the two drugs, up to a maximal effect. Potentiation is a special case of synergism in which one drug has no effect but can increase the activity of another drug.

REF: p. 28

34. This term is used to describe when two drugs act on the same receptors and the combined effect is the simple linear sum of the effects of the two drugs, up to a maximal effect.

a. Potency
b. Hypersensitivity
c. Potentiation
d. Additivity

ANS: D
Hypersensitivity describes an allergic or immune-mediated response to a drug, which can be serious, requiring airway maintenance or ventilatory assistance. Potency refers to the concentration (EC_{50}) or dose (ED_{50}) of a drug producing 50% of the maximal response of the drug. Additivity occurs when two drugs act on the same receptors and the combined effect is the simple linear sum of the effects of the two drugs, up to a maximal effect. Potentiation is a special case of synergism in which one drug has no effect but can increase the activity of another drug.

REF: p. 28

35. Why is lipid diffusion an important mechanism for drug absorption?
a. Many epithelial membranes must be crossed if a drug is to distribute in the body and reach its target organ.
b. Epithelial cells do not have lipid membranes, so a drug must be water-soluble to diffuse across such a membrane.
c. It is directly related to the proportion of a drug that reaches the systemic circulation.
d. Lipid diffusion has no importance in drug absorption because the body has very few epithelial membranes drugs must cross.

ANS: A
Lipid diffusion is an important mechanism for drug absorption because many epithelial membranes must be crossed if a drug is to distribute in the body and reach its target organ.

REF: p. 15

36. The term used to indicate the proportion of a drug that reaches the systemic circulation is
a. bioavailability.
b. biotransformation.
c. pharmacokinetics.
d. structure-activity relationship.

ANS: A
Bioavailability refers to the amount of a drug that reaches the systemic circulation. Biotransformation is the transformation of a drug into a metabolite or inactive form. Pharmacokinetics describes the time course and disposition of a drug in the body. The relationship between a drug's chemical structure and its clinical effect or outcome on the body is termed the structure-activity relationship (SAR).

REF: p. 11

37. The process by which a drug is transported to its sites of action, eliminated, or stored is referred to as
a. bioavailability.
b. biotransformation.

c. drug distribution.
d. plasma half-life.

ANS: C
Bioavailability refers to the amount of a drug that reaches the systemic circulation. Biotransformation is the transformation of a drug into a metabolite or inactive form. Drug distribution is the process by which a drug is transported to its sites of action, eliminated, or stored. Plasma half-life ($T_{1/2}$) is the time required for the plasma concentration of a drug to decrease by one-half.

REF: p. 15 | p. 16

38. The time required for the plasma concentration of a drug to decrease by one-half is referred to as
a. bioavailability.
b. biotransformation.
c. drug distribution.
d. plasma half-life.

ANS: D
Bioavailability refers to the amount of a drug that reaches the systemic circulation. Biotransformation is the transformation of a drug into a metabolite or inactive form. Drug distribution is the process by which a drug is transported to its sites of action, eliminated, or stored. Plasma half-life ($T_{1/2}$) is the time required for the plasma concentration of a drug to decrease by one-half.

REF: p. 18

39. After inhalation of an aerosol by a spontaneously breathing patient with no artificial airway, a proportion of the aerosol does which of the following?
1. Impacts in the oropharynx
2. Is swallowed
3. Is absorbed by the lungs
4. Is exhaled

a. 1 and 2 only
b. 1 and 3 only
c. 1, 2, and 3 only
d. 1, 2, 3, and 4

ANS: C
After inhalation of an aerosol by a spontaneously breathing patient with no artificial airway, a proportion of the aerosol impacts in the oropharynx and is swallowed, and a proportion is inhaled into the airway. Because a portion of an inhaled aerosol is swallowed, the inhalation route leads to gastrointestinal absorption, as well as lung absorption of the drug. The traditional percentages given for stomach and airway proportions, based on Stephen Newman's classic measures in 1981 with an MDI, are approximately 90% and 10%, respectively.

REF: p. 20 | p. 21