

CHAPTER 2

Multiple Choice: Select the appropriate answer(s):

1. Which of the following routes of drug administration is used for the placement of Arestin (minocycline)?
 - a. transdermal
 - b. topical
 - c. intramuscular
 - d. subcutaneous
 2. Which of the following terms describes the actions of a tablet on the body after ingestion and absorption?
 - a. pharmacology
 - b. pharmacokinetics
 - c. pharmacodynamics
 - d. toxicology
 3. Which of the following terms describes the absorption of lidocaine local anesthetic after it is injected into the tissues?
 - a. pharmacokinetics
 - b. pharmacodynamics
 - c. toxicology
 - d. adverse drug event
 4. Which of the following dosage forms describes chlorhexidine gluconate oral rinse?
 - a. emulsion
 - b. solution
 - c. suppository
 - d. elixir
 5. From the following list, select the items associated with enteral drug administration
 - a. oral
 - b. sublingual
 - c. intravenous
 - d. subcutaneous
 - e. rectal
 - d. transdermal
 - e. subgingival
 - f. inhalation
 - g. intramuscular
-

6. From the following list select the items associated with adverse drug reaction
- noxious drug response
 - unintended response to a drug
 - reaction occurs to properly prescribed drug (normal dose or amount)
 - medical errors (miscalculation of dose)
 - confusion with name of drug prescribed (sounds similar to other drugs)
7. By which of the following routes of administration is insulin usually taken?
- oral
 - subcutaneous
 - intramuscular
 - rectal
8. Which of the following routes of administration should a dental patient use for a nicotine patch?
- oral
 - topical
 - transdermal
 - rectal
9. Nitroglycerin tablets are taken
- sublingually.
 - transdermally.
 - topically.
 - intramuscularly.
10. Oraquix is a local anesthetic applied subgingivally. Which of the following routes of drug administration is used to deliver the anesthetic?
- topical
 - oral
 - transdermal
 - parenteral
11. Pharmacokinetics involves all of the following concepts?
- absorption
 - distribution
 - metabolism
 - elimination
 - binding
12. Which of the following terms is used for metabolism?
- biotransformation
 - excretion
 - liberation
 - elimination
13. Which of the following terms describes how much of a drug will be available in the body to produce a pharmacologic response after it is administered?
- bioequivalence
 - bioavailability
 - biotransformation
 - liberation
14. Absorption is bypassed if a drug is administered by which route?
- topical
 - inhalation
 - intravenous
 - rectal
-

15. Which of the following drug characteristics will increase the tendency of a drug to cross cell membranes?
 - a. ionized and high lipid solubility
 - b. nonionized and high lipid solubility
 - c. nonionized and low lipid solubility
 - d. ionized and low lipid solubility
 16. How many half-lives does it take for a drug to be eliminated from the body?
 - a. 1-2
 - b. 2-3
 - c. 4-5
 - d. 5-6
 17. Sublingual or buccal administered drugs must initially be able to go through the
 - a. epithelium of the oral mucosa (tongue or buccal mucosa).
 - b. connective tissue of the GI tract.
 - c. tissues of the stomach.
 - d. tissues of the nasopharynx.
 18. Which of the following routes of drug absorption into the bloodstream is most common?
 - a. passive diffusion
 - b. active transport
 - c. facilitated diffusion
 - d. protein transport
 19. All of the following alter the rate of absorption of drugs except one. Which one is the exception?
 - a. fatty foods
 - b. blood flow to the target organ
 - c. hydrogen ion concentration
 - d. surface area of the esophagus
 20. Orally administered drugs must pass through the liver (via the hepatic portal vein) prior to reaching general circulation and site of action. This is referred to as
 - a. enterohepatic circulation.
 - b. first-pass metabolism.
 - c. passive diffusion.
 - d. distribution.
 21. Which of the following terms describes the movement of a drug once it is absorbed throughout the body fluids to organs/tissues, which are the site of drug action?
 - a. absorption
 - b. liberation
 - c. distribution
 - d. elimination
 22. Which route(s) of drug administration undergoes significant enterohepatic circulation?
 - a. oral
 - b. intravenous
 - c. intramuscular
 - d. subcutaneous
 23. The primary site of drug biotransformation is the
 - a. gallbladder.
 - b. small intestine.
 - c. large intestine.
 - d. liver.
 24. Which of the following enzymes found in the liver is primarily responsible for the biotransformation of many dental drugs?
-

- a. collagenase
 - b. cytochrome P450
 - c. hyaluronidase
 - d. elastase
25. The time it takes for the drug to eliminate 50% of the amount of its concentration in the plasma or body is referred to as its
- a. half-life.
 - b. excretion.
 - c. zero-order kinetics.
 - d. clearance.
26. The capacity of a body to eliminate a drug is referred to as
- a. drug clearance.
 - b. half-life.
 - c. steady-state.
 - d. tubular reabsorption.
27. Which of the following terms describes the actions a drug has on the body?
- a. pharmacokinetics
 - b. pharmacodynamics
 - c. pharmacology
 - d. toxicology
28. A drug that rapidly combines with a receptor to initiate a response and rapidly dissociates or releases from the receptor is called a (an)
- a. agonist.
 - b. antagonist.
 - c. receptor.
 - d. ligand.
29. Which of the following terms describes the drug dose that produces 50% of the maximum possible response?
- a. effective dose (ED_{50})
 - b. lethal dose
 - c. maximum response
 - d. half-life ($t^{1/2}$)
30. Tachyphylaxis is a very rapid development of
- a. tolerance.
 - b. adaptation.
 - c. mutation.
 - d. adjustment.
31. The term used to describe a decreased response to repeated administration of a drug is
- a. drug dependence.
 - b. drug interaction.
 - c. tachyphylaxis.
 - d. tolerance.
32. Receptors for drug binding are primarily composed of
- a. protein.
 - b. fat.
 - c. part of the drug.
 - d. cell membrane.
33. When a drug enters the blood, it may bind to molecules such as albumin, which makes the drug inactive. This is termed
- a. protein binding.
 - b. protein affinity.
-

- c. drug action.
 - d. drug binding.
34. All of the following are disadvantages of orally administered drugs except one. Which one is the exception?
- a. undergoes first-pass effect
 - b. food interferes with absorption
 - c. cannot take if patient is vomiting
 - d. convenient form to administer
35. A maintenance dose of drug is given to
- a. achieve an initial high drug concentration.
 - b. keep blood concentration in the therapeutic range.
 - c. allow the drug concentration to drop to 50% of its initial concentration.
 - d. achieve a maximal response.

True or False

- 1. After a drug is taken orally, it immediately passes into the bloodstream.
- 2. Cell membranes are composed of three layers of fat.
- 3. A drug that is soluble in fat is called hydrophilic.
- 4. Passive diffusion of drugs across cell membranes/tissue barriers does not require energy.
- 5. A lipophilic drug is more easily excreted in the urine.
- 6. Weak acids such as aspirin are more readily absorbed from the stomach than weak bases.
- 7. Drugs that are weak bases (e.g., erythromycin, codeine, and morphine) are more lipid soluble and have greater absorption in the small intestine.
- 8. Morphine has to be injected because it has a high first-pass metabolism.
- 9. Polar drugs that are not metabolized are excreted unchanged in the urine.
- 10. Drug dose is defined as the quantity of drug administered.
- 11. A drug that is administered intravenously has 100% bioavailability.
- 12. Administration of lidocaine with epinephrine is by intramuscular injection.
- 13. Application of benzocaine 20% is topical.
- 14. Atridox is administered intramuscularly.

Fill in the Blank

1. Once a drug is orally administered into the body, it must be into the bloodstream.
 2. F refers to how much of a drug is absorbed into the blood after the dose is administered.
 3. A drug that is intravenously injected has 100 percent bioavailability.
 4. Orally administered drugs are absorbed in the stomach
 5. Before a drug is absorbed into the blood, the drug must be absorbed through many barriers on its way from the GI tract into the blood.
 6. The barrier membrane between the blood and the tissue is called the endothelial barrier.
 7. During simple diffusion the drug penetrates the membrane exclusively by diffusion, in which the rate of transport is solely proportional to the concentration gradient.
-

8. Unlike enteral-administered drugs, administration of drugs bypasses the gastrointestinal tract.
9. The major barrier to absorption of topical administration of a drug is the top layer of skin called the .
10. A drug is eliminated either unchanged or as a .
11. To be readily excreted in the urine a drug must be in a soluble form.
12. A is inactive when administered orally but becomes active after metabolism in the liver.
13. The enzymes in the liver are called enzymes.
14. Most drugs undergo of elimination.
15. The purpose of giving a dose is to rapidly establish a therapeutic plasma drug concentration.
16. The site of drug attachment on the tissue is called the .
17. A response is the dose of drug that will give the greatest response, and increasing the dose will not increase the response.
18. The of a drug is the dose or amount of drug required to produce a particular or specific biologic effect.
19. is a homeostatic adjustment that may occur during a continued or prolonged presence of a drug.
20. A is a treatment during research that is similar to the active medication except that it does not contain the active drug.
21. is the application of drugs to the skin that will be absorbed into the bloodstream.
22. An injection is used when performing the tuberculin skin test for tuberculosis.
23. Oraqix is administered by the route.
24. Arestin is applied in the .

EXTENDED MATCHING

1.

For each route of drug administration listed below, select the correct drug that is administered by that route of administration from the list provided

<u>Route of drug administration</u>	<u>Drug</u>
1. transdermal	a. dental anesthetic (e.g., lidocaine)
2. subcutaneous	b. hepatitis B vaccine
3. intramuscular	c. nicotine patch
4. topical	d. Arestin or Atridox
	e. insulin
	f. benzocaine 20%

2.

For each term listed below, select the correct definition from the list provided

1. half-life	a. rate and extent to which a drug is absorbed
2. affinity	b. time taken for the blood concentration of a drug to decrease 50% or one-half its concentration
3. bioavailability	c. binding of a drug to a receptor

- 4. pharmacokinetics
- 5. pharmacodynamics
- 6. ceiling effect
- d. therapeutic response cannot be increased with a higher dose of the drug
- e. the effects of drugs on the body and mechanisms of drug action
- f. absorption of a drug
- g. distribution of a drug through the blood
- h. metabolism of a drug

Case Study

A 75-year-old male patient comes to the dental office for regular maintenance visits. The patient has hypercholesterol levels and is taking simvastatin (Zocor). He presents to the office with an intraoral swelling around the mandibular first molar region. A radiograph was taken and revealed a large radiolucent area. Root canal treatment will have to be started. The patient is given a prescription for penicillin V.

License: 0111111
DEA # AW123445555

John David, DDS
1111 Main Street
New York, NY 11111

(212) 111-1234

Name Mary Smith Age 35
Address 1234 South St, NY Date 7/1/06

Penicillin VK 500mg

Disp: # 29 tabs

Sig: Take two tablets orally at once, followed by one tablet four times a day.

-

This prescription will be filled generically unless prescriber writes "daw" in the box below

label

1. Why is it important to ask this patient if he has any allergies?
 2. Why is an initial dose of 1000 mg (2 tablets of 500 mg) given to the patient?
 3. What should be reviewed before the prescription is given to the patient?
 4. What pharmacokinetic factor should be considered when prescribing this antibiotic to the patient?
 5. When the patient swallows the tablet how does it reach the site of action? Also, what is the intended site of action in this patient?
-

CHAPTER 2

Multiple Choice

1. b. Placement of medications used in periodontics (such as a Atridox or Arestin) into the gingival crevice is an example of topical administration (referred to as subgingival) because they are medications applied to the epithelium.
 2. c. Pharmacodynamics refers to the actions a drug has on the body, including the drug's mechanism of action, receptor interactions, dose-response relationship, and therapeutic and toxic reactions. Pharmacokinetics describes what the body does to drugs.
 3. a. Pharmacokinetics describes how the drug is handled by the body, including absorption, distribution, metabolism, and elimination.
 4. b. Solutions are a clinically and physically homogenous mixture of two or more substances. Solutions are generally liquid: chlorhexidine gluconate + alcohol.
-

5. a,b,e. Oral, sublingual and rectal routes of drug administration involve the drug being absorbed from the GI tract. There other routes of drug administration are parenteral and avoid the GI tract.
 6. a, b,c. Adverse drug reaction is a noxious and unintended response to a drug or medical device or product as long as the drug was properly prescribed regarding normal dose, route. Medical errors are not included in the definition of adverse drug reaction. An adverse drug event includes medical errors.
 7. b. Administration of a drug involves the injection of liquid into the connective tissue under the skin. This route cannot be used for irritating drugs or if a large volume of the drug (solution) must be administered.
 8. c. Transdermal administration is the application of drugs to the skin that will be absorbed into the bloodstream. Dosage forms include a skin patch or ointment. Common patches include nitroglycerin for angina, oral contraceptives, and nicotine patches for smoking cessation.
 9. a. Nitroglycerin tablets to relieve acute angina pain are placed under the tongue (sublingually) for quick absorption and relief.
 10. c. Oraqix, a topical anesthetic, is applied directly into the gingival crevice.
 11. a,b,c,d. Absorption, distribution, metabolism, and elimination are all involved in the actions of the body to the administered drug. Protein binding is what the drug does in the body and is not part of pharmacokinetics.
 12. a. Biotransformation refers to the metabolism or changing/altering the drug so that it can be eliminated from the body.
 13. b. Bioavailability of a drug refers to how much of a drug is absorbed or appears in the bloodstream after a dose is administered.
 14. c. A drug given IV directly goes into the bloodstream.
 15. b. A more lipid-soluble, nonionized drug will pass through the biphospholid layer of the cell membrane.
 16. c. Half-life ($t_{1/2}$) of elimination is the time it takes for the concentration of the drug in the blood to fall to half (50%) of its original value. It is an indicator of how long a drug will produce its effect in the body and defines the time interval between doses. It takes about 4–5-lives for a drug to be “considered” eliminated from the body. At this point, steady-state is reached.
 17. a. Sublingually or buccally administered drugs must be able to go through the epithelium of the oral mucosa (tongue or buccal mucosa) before they can enter the blood and be distributed to the site of action. This barrier is referred to as the tissue/blood barrier.
 18. a. During passive diffusion, the drug penetrates the membrane exclusively by diffusion in which the rate of transport is solely proportional to the concentration gradient.
 19. d. The surface area of the small intestine is of concern for absorption. The drug just passes down the esophagus, which is not involved in absorption.
 20. b. Drugs are absorbed from the gut but may be biotransformed by enzymes in the gut and liver before reaching the systemic circulation. This process lowers their degree of bioavailability.
 21. c. Distribution is the process by which the effective concentration of the drug is reached at the site of action.
 22. a. Many drugs are excreted in the bile. After the bile empties into the intestines, part of the drug may be reabsorbed back into the blood (circulation) and eventually return to the liver. This process reduces the elimination of drugs and prolongs their half-life and duration of action in the body.
 23. d. The liver is the primary site where drugs are biotransformed or changed in order to prepare them for elimination from the body.
-

24. b. CYP enzymes are involved in oxidative or reductive metabolism. For example, CYP3A4 is responsible for the biotransformation of cholesterol-lowering statin drugs, and if taken with erythromycin/clarithromycin, will inhibit the metabolism of these drugs because CYP3A4 is an enzyme inhibitor.
25. a. Drugs with a first-order elimination exhibit a half-life ($t_{1/2}$) of elimination, which is the time it takes for the drug to eliminate half (50%) of the amount of its concentration in the plasma or body. For example, if the elimination $t_{1/2}$ of a drug is 20 minutes, 50% of it remains in the blood 20 minutes after IV administration. This is a mathematical calculation that is important for adequate drug dosing.
26. a. Total body clearance is a more accurate measure of the efficiency with which a drug is eliminated by the body than the half-life ($t_{1/2}$).
27. b. Pharmacodynamics describes the actions a drug has on the body; the drug's mechanism of action. Additionally, pharmacodynamics involves drug-receptor interactions, drug response, and dose-response relationship.
28. a. Agonist is a drug that rapidly combines with a receptor to initiate a response and rapidly dissociates or releases from the receptor. It has a high efficacy. Most drugs used today are agonists. An antagonist is a drug that binds to the receptor but does not dissociate and has no positive response and no efficacy. A ligand is a molecule or drug that binds to a receptor to form a larger complex.
29. a. Effective dose is the dose that produces 50% of the maximal response. The potency of a drug varies inversely with a drug's ED_{50} . For example, a drug whose ED_{50} is 4 mg is ten times more potent than a drug whose ED_{50} is 40 mg.
30. a. Tachyphylaxis, a very rapid development of tolerance, is defined as a rapid decreasing response (within hours/days) with repeated administration of the same dose of drug at short intervals. In dental practice, tachyphylaxis to local anesthetics may develop. For example, a local anesthetic is administered to a dental patient. Once the nerve function returns to its preinjection state and the patient requires more anesthetic because of pain, the duration and intensity of anesthesia with reinjection is greatly diminished. Thus, successive doses of the anesthetic will be less effective than those given previously.
31. d. Tolerance is defined as the need for increasing amounts of drug to obtain the same therapeutic effect.
32. a. Receptors are usually macromolecules composed of proteins, carbohydrates, and glycoproteins.
33. a. Drugs binding to plasma proteins is a reversible action. A highly protein-bound drug has a longer duration of action. Only a free drug, not bound to plasma proteins, is active. One drug may displace another from its binding site on the protein, elevating the free concentration of the displaced drug. This is a type of drug interaction. An example of a highly protein-bound drug is warfarin (a blood thinner).
34. d. Tablets and capsules are easier to administer than an injectable drug form.
35. b. Before plasma levels can drop back toward zero, intermittent maintenance doses are administered to keep blood concentrations in the therapeutic range.

True or False

1. F: Once a drug is taken orally, it initially passes down the esophagus and into the small intestine before it is absorbed into the blood.
-

2. F: Cell membranes or tissue barriers are composed of two layers of lipids (fat), referred to as the biphospholipid layers with small aqueous (water) holes, channels or pores throughout the layers with proteins on the outside.
3. F: A drug that is soluble in fat is called lipophilic and hydrophilic when soluble in water.
4. T: The rate of absorption increases as long as the concentration outside the cell (circulatory system; blood) is greater than the concentration inside the cell (target tissue; where the drug acts). No energy is used by the cell.
5. F: A hydrophilic drug is more water soluble and easier to be excreted.
6. T: Drugs that are weak acids will be mostly nonionized at the acid pH of the stomach (pH 1), allowing them to be readily absorbed.
7. T: Drugs that are weak will be more nonionized (nonpolar) at the pH of the basic small intestine (pH 6-7) and ionized, more polar, and more water soluble in the stomach. The nonionized portion of the drug shows great lipid solubility and therefore greater absorption in the small intestine.
8. T: Drugs that have a high first-pass effect are biotransformed in the liver with less of the drug being available to get to the site of drug action.
9. T: Water-soluble drugs are easily excreted in the urine and do not have to be biotransformed as do lipid-soluble drugs.
10. T: The dose of a drug refers to the amount of drug given.
11. T: Intravenous administration (IV) of a drug is made directly into the circulation (vein) so it is used for emergency situations when it is critical to get the drug into the blood as quickly as possible.
12. F: All dental anesthetic injections are subcutaneous injections.
13. T: Topical administration refers to the application of drugs to the surface of the body (e.g., skin, mucous membranes of the gingiva, eyes, gingival crevice of teeth, mouth, and throat).
14. F: Local delivery of antibiotics (Arestin, Atridox) used in periodontics are administered topically into the gingival crevice.

Fill in the Blank

1. absorbed: Drugs must be absorbed from the GI tract into the blood before they can get to the site of action and exert a pharmacologic response.
 2. Bioavailability: Once a drug is administered, it must be absorbed into the blood. This is referred to as bioavailability.
 3. 100%: A drug that is administered IV goes directly into the bloodstream and does not have to go through any barriers to get into the blood. Thus, it is 100% absorbed.
 4. small intestine: The small intestine has a larger surface area for absorption than the stomach.
 5. tissue barriers: Drugs must pass through tissue barriers or cell membranes from the GI tract to the blood and then from the blood to the site of action.
 6. blood/tissue: Once the drug enters the blood, it is transported to the various tissues in the body through body fluids until it passes through blood (capillary) cell membranes to get to the site of action where the drug will exert its pharmacological effect(s). Thus, the drug must go through another barrier. This barrier membrane between the blood and the tissue is called the blood/tissue barrier.
 7. passive: This is the most common route of drug passage into the blood.
-

8. parenteral: Orally administered drugs must go through the GI tract before being absorbed into the blood, whereas parenteral (injectable) drugs bypass the GI tract.
9. stratum corneum: The stratum corneum is the most superficial layer of skin and a topically applied drug must pass through it.
10. metabolite: Drugs are eliminated either as the original parent compound (referred to as "unchanged") or as a drug metabolite where the drug molecule must be changed or metabolized in the body for it to be eliminated
11. water: To be readily eliminated from the body, a drug must be in a water-soluble/polar form. Thus, many drugs must be changed (biotransformed) before elimination, and the liver is the primary site of drug biotransformation.
12. prodrug: A prodrug is only active once it reaches the liver.
13. cytochrome P450: These enzymes are responsible for biotransforming many drugs and are involved in many drug/drug interactions.
14. first-order: Most drugs undergo first-order kinetics of elimination, whereby drug elimination is proportional to drug concentration. That is to say, after a drug is given orally, it will be absorbed by passive diffusion, and the blood levels attained will be proportional to the dose administered. Thus, the greater the dose administered, the larger will be the blood level concentration. As the drug is eliminated from the body, the concentration of the drug in the plasma will decrease equally over time.
15. loading: A loading dose establishes initial therapeutic plasma drug concentrations.
16. receptor: The site where such drug attachment takes place is termed the receptor and is regarded as being specific cell molecules.
17. maximum: A maximum response is the dose of drug that will give the maximum response, and increasing the dose will not increase the response. The minimal effective dose is the dose below which no response is elicited.
18. potency: Potency is the dose required to produce a defined magnitude of drug effect. Potency of a drug varies inversely with a drug's ED₅₀.
19. Adaptation: The body adjusts itself and minimizes the affects of the drug.
20. placebo: An individual given a placebo will report experiencing effects that would have been expected when receiving the active drug. This is called the placebo effect. Placebos are usually required as control in FDA clinical trials.
21. solid dosage form
22. intradermal. An intradermal injection is made directly into the dermis layer of the skin, which is below the epidermis. Intradermal injections are given to test for allergy reactions and for tuberculin skin test.
23. topical route: Oraqix is administered into the gingival crevice, which is a type of topical administration. Oraqix (lidocaine and prilocaine) periodontal gel is a needless application of local anesthetic in periodontal pockets.
24. gingival crevice: Arestin is applied by topical administration directly into the periodontal pocket.

EXTENDED MATCHING

1.

1. c
 2. a, e
-

3. b
4. d, f

2.

1. b
2. c
3. a
4. f, g, h
5. e
6. d

Case Study

1. The patient should be questioned regarding allergies to medications before the prescription for penicillin is given. Ask the patient directly if he is allergic to penicillin. Taking a drug that someone is allergic to can result in a mild rash or a severe anaphylactic shock resulting in death.
2. This is called a loading dose. The purpose of giving a loading dose is to rapidly establish a therapeutic plasma drug concentration. A large loading dose may be required initially in order to achieve a rapid response in situations that are life-threatening. A maintenance dose (500 mg four times a day) maintains a desired drug concentration in the plasma. Steady-state plasma concentration refers to the point at which the rate of drug administration is equal to the rate of drug elimination.
3. The patient's drug history should be reviewed before giving a prescription. Any drug-drug, drug-disease, or drug-food interactions should be noted before the prescription is given to the patient. For instance, if the patient were allergic to penicillin and erythromycin or clarithromycin (Biaxin) were prescribed instead, then there would be a drug interaction because simvastatin is biotransformed by CYP3A4 enzymes in the liver. Erythromycin/clarithromycin are potent inhibitors of this enzyme, which would result in elevated simvastatin blood levels. Thus, erythromycin/clarithromycin is contraindicated in this patient.
4. Consider factors that affect the absorption of the drug. Penicillin V should be taken on an empty stomach (one hour before or two hours after eating) for more complete absorption from the GI tract into the blood. Elimination of the drug is delayed in patients with renal disease, thus the dose would have to be adjusted.
5. The infected tooth and surrounding tissues are the site of action where the penicillin will exert its antibiotic effect.

The following are steps involved in the actions of the antibiotic:

- a. The penicillin is swallowed in the mouth.
 - b. It goes down the esophagus into the stomach and then into the small intestine.
 - c. Since penicillin is a weak acid, it is readily absorbed from the upper regions of the GI tract (stomach), where it is primarily in an unionized form.
 - d. Food in the GI tract will reduce the absorption of penicillin.
 - e. Before the penicillin enters the general circulation, it goes through the portal vein into the liver where it undergoes first-pass effect—biotransformation by enzymes in the liver—then the penicillin enters the general circulation.
 - f. Penicillin is fairly well distributed to most body fluids and bone and appears in breast milk.
 - g. Now the molecule undergoes biotransformation and excretion in order to reduce the plasma drug concentration.
-

- h. Penicillin is not metabolized much in the body so that it is excreted rapidly unchanged in the urine.

