The National Medical Series for Independent Study

pharmacology

EDITOR

Leonard S. Jacob, M.D., Ph.D.

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Leonard S. Jacob, M.D., Ph.D.

Visiting Associate Professor
of Pharmacology
Medical College of Pennsylvania
Vice-President, Clinical Research and
Development, North America
Smith Kline & French Laboratories
Philadelphia, Pennsylvania

ASSOCIATE EDITORS

John S. Lazo, Ph.D.

Associate Professor
Department of Pharmacology
Yale University School of Medicine
New Haven, Connecticut

Edward Hawrot, Ph.D.

Assistant Professor
Department of Pharmacology
Yale University School of Medicine
New Haven, Connecticut

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Efforts have been made by the authors and editors of this book to ensure accuracy and immediacy in drug dosage schedules. However, *Pharmacology* is not intended as a guide to drug therapy. It is urged that the readers consult the manufacturer's package insert to ascertain the recommended drug dosage, administration, and contraindications, especially relative to new and seldom-used drugs.

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Preface

In the expanding world of science and medicine it is impossible to be "truly" up-to-date in any defined area. Pharmacology is no exception. In any pharmacology course, the student is confronted with a new language to which many additions will occur. New agents, their mechanisms of action, and untoward effects must be continually added to the already overburdened core knowledge of pharmacology. Understanding this new language is not easy because it is predicated on a thorough understanding of the basic medical sciences, including physiology and biochemistry.

I have personally gone through this educational process in the last 10 years, and although it has been rewarding, it has often been confusing. Most standard major textbooks of pharmacology provide an abundance of detail, which precludes the student from ever reading the book within the confined period of a 24- to 36-week course. Additionally, preparing for the National Boards requires the student to distill an extraordinary amount of information. The large number of drug groups has made it difficult to decipher which agent is or is not important. *Pharmacology* is designed as a *review* textbook, which attempts to present to the student numerous drug groups in an organized fashion.

National Board–type questions are presented, and detailed answers are provided. This is done not only to determine the extent of the preparation that might still be needed prior to taking this very important exam but additionally to reinforce important concepts presented in this textbook. It is important to stress that *Pharmacology* should not serve as a replacement for the major textbooks when detailed references are needed but instead should provide the information necessary for preparing for the pharmacology section of the National Medical Boards.

Leonard S. Jacob

Acknowledgments

The writing and editing of this textbook has been extraordinarily difficult. Drs. John Lazo and Edward Hawrot, as Associate Editors, have looked upon my writing from a different perspective, and their contributions have added greatly to the overall quality of this review book. I am also grateful to Bruce Pitt, Ph.D., and Priscilla Dannies, Ph.D., of Yale University, for reviewing many chapters. Paul D. Denenzi, a Yale medical student, has also provided many helpful comments and suggestions. The editors at Harwal Publishing Company have been many, including Gloria Hamilton, Mary Ann Sheldon, and Jane Edwards. All were constructive, and Ms. Edwards in particular was patient in accommodating my busy schedule. Finally, my thanks is extended to Joseph Uri, M.D., Ph.D., a colleague and friend, who ensured that the "final product" met my goals in both accuracy and quality.

Introduction

Pharmacology is one of seven basic science review books in a series entitled, *The National Medical Series for Independent Study*. This series has been designed to provide students, house officers, as well as physicians, with a concise but comprehensive instrument for self-evaluation and review within the basic sciences. Although *Pharmacology* would be most useful for students preparing for the National Board of Medical Examiners examinations (Part I, FLEX, VQE, and ECFMG), it should also be useful for students studying for course examinations. These books are not intended to replace the standard basic science texts, but, rather, to complement them.

The books in this series present the core content of each basic science area using an outline format and featuring a total of 300 study questions. The questions are distributed throughout the book at the end of each chapter and in a pretest and post-test. In addition, each question is accompanied by the correct answer, a paragraph-length explanation of the correct answer, and specific reference to the outline points under which the information necessary to answer the question can be found.

We have chosen an outline format to allow maximum ease in retrieving information, assuming that the time available to the reader is limited. Considerable editorial time has been spent to ensure that the information required by all medical school curricula has been included and that each question parallels the format of the questions on the National Board examinations. We feel that the combination of the outline format and board-type study questions provides a unique teaching device.

We hope you will find this series interesting, relevant, and challenging. The authors, as well as the John Wiley and Harwal staffs, welcome your comments and suggestions.

Contents

Pretest

QUESTIONS

Directions: Each question below contains five suggested answers. Choose the **one best** response to each question.

1. A postmenopausal woman presents with a breast carcinoma that is rich in estrogen receptors. The drug most likely to be administered is

(A) bleomycin
(B) vinblastine
(C) mitomycin
(D) dacarbazine
(E) tamoxifen

2. Scopolamine most closely resembles which of the following agents in its pharmacologic actions?

(A) Hexamethonium
(B) Atropine
(C) Succinylcholine
(D) Acetylcholine
(E) Curare

3. Physiologic doses of glucocorticoids can result in all of the following changes EXCEPT

(A) decreased liver glycogen stores
(B) increased gluconeogenesis
(C) increased lipolysis
(D) increased hemoglobin synthesis
(E) decreased cardiovascular function

4. Basic considerations for the treatment of hypertension should include all of the following EXCEPT

(A) initial drug therapy for mild hypertension could include minoxidil
(B) a combination of a diuretic and a β-adrenergic blocking agent can be used if either drug is ineffective alone
(C) when arteriolar vasodilators are used, appropriate sympathetic blockers are administered to prevent a reflex sympathetic response
(D) hypertensive emergencies are best treated with parenteral therapy
(E) diuretic agents are effective for patients requiring long-term treatment of hypertension

5. Which of the following statements concerning physiologic or pharmacologic antagonism is correct?

(A) In physiologic antagonism, the agonist has no intrinsic activity
(B) In physiologic antagonism, the antagonist has no intrinsic activity
(C) In physiologic antagonism, the antagonist and the agonist act on the same receptor
(D) In pharmacologic antagonism, the agonist has intrinsic activity
(E) In pharmacologic antagonism, the agonist has no intrinsic activity

Questions 6 and 7

A 10-year-old boy is admitted to the hospital with an initial diagnosis of acute lymphoblastic leukemia. His liver, spleen, and lymph nodes are extensively infiltrated.

6. Which of the following drug combinations would be most appropriate for inducing remission?

(A) Prednisone and vincristine
(B) Cyclophosphamide and methotrexate
(C) Cyclophosphamide and vinblastine
(D) 6-Mercaptopurine and methotrexate
(E) Cytarabine and 5-fluorouracil

7. The patient is given allopurinol to reduce the complications of his cancer chemotherapy. The rationale underlying the allopurinol therapy is that

(A) allopurinol increases the renal clearance of uric acid
(B) the most effective therapeutic regimens interfere with purine biosynthesis
(C) rapid lympholysis produces large quantities of uric acid
(D) lower doses of the remission-inducing drugs can be given
(E) allopurinol inhibits the metabolism of pyrimidine analogs

8. Mercury is toxic because it

(A) complexes with hemoglobin to form methemoglobin
(B) inhibits hemoglobin synthesis, producing anemia
(C) binds to ferric ions of the cytochrome a-a_3 complex
(D) inhibits anaerobic glycolysis
(E) binds to sulfhydryl groups

9. The diuretic of choice for a patient receiving the nephrotoxic antitumor agent cisplatin is

(A) ethacrynic acid
(B) mercaptomerin
(C) acetazolamide
(D) chlorothiazide
(E) mannitol

10. During a regular prenatal checkup, Mrs. Jones is found to have a normochromic, megaloblastic anemia. The most likely cause is a deficiency of

(A) iron
(B) vitamin B_{12}
(C) vitamin K
(D) folic acid
(E) intrinsic factor

11. Untoward effects seen with nitrites include all of the following EXCEPT

(A) headache
(B) increased intracerebral pressure
(C) methemoglobinemia due to oxidation of hemoglobin by the nitrite ion
(D) postural hypotension
(E) impotence

12. Exacerbation of petit mal seizures, gastrointestinal irritation, gingival hyperplasia, and facial hirsutism are all possible side effects of which one of the following anticonvulsant drugs?

(A) Phenobarbital
(B) Carbamazepine
(C) Acetazolamide
(D) Phenytoin
(E) Valproic acid

13. Furosemide is useful for the treatment of all of the following conditions EXCEPT

(A) congestive heart failure
(B) acute pulmonary edema
(C) hypocalcemia
(D) edema resulting from hepatic or renal disease
(E) hypertensive crisis

14. All of the following statements about untoward effects of cardiac glycosides are true EXCEPT that

(A) they have a high margin of safety
(B) intoxication is often precipitated by the depletion of potassium
(C) decreased renal function can predispose to toxicity
(D) the glycosides can cause vision changes
(E) the glycosides can cause ventricular tachycardia

15. The first-pass effect occurs most often after

(A) oral administration of a drug
(B) sublingual administration of a drug
(C) intravenous administration of a drug
(D) subcutaneous administration of a drug
(E) intramuscular administration of a drug

16. Atropine is useful in treating poisoning produced by organophosphate insecticides because it

(A) reactivates inhibited acetylcholinesterase
(B) stimulates α receptors directly
(C) stimulates β receptors directly
(D) inhibits normal ganglionic transmission
(E) blocks the action of acetylcholine at both central and peripheral sites

17. A patient with a history of glaucoma, epilepsy, and edema would be a candidate for treatment with which of the following diuretics?

(A) Ethacrynic acid
(B) Chlorothiazide
(C) Furosemide
(D) Acetazolamide
(E) Spironolactone

18. Characteristics of the partial agonist-antagonist opioid agents (e.g., pentazocine) include

(A) severe nausea as a side effect
(B) a lack of correlation, at all therapeutic doses, between analgesic potency and depressant potency
(C) an increase in peripheral resistance and pulmonary vascular resistance, resulting in increased cardiac work
(D) a lack of constipating effects
(E) absence of tolerance to the analgesic effect

19. The potential for digitalis-induced cardiac arrhythmias is increased by each of the following diuretics EXCEPT

(A) ethacrynic acid
(B) chlorothiazide
(C) spironolactone
(D) furosemide
(E) mercaptomerin

20. Which of the following statements best characterizes morphine?

(A) It has a more rapid onset of action than heroin
(B) It has low addiction capabilities compared with heroin
(C) It can increase biliary tract pressure
(D) It always produces euphoria
(E) It blocks the chemoreceptor trigger zone

Directions: Each question below contains four suggested answers of which **one or more** is correct. Choose the answer

A if **1, 2, and 3** are correct
B if **1 and 3** are correct
C if **2 and 4** are correct
D if **4** is correct
E if **1, 2, 3, and 4** are correct

21. Ascariasis can be effectively treated by

(1) piperazine
(2) metronidazole
(3) pyrantel pamoate
(4) suramin

22. A patient with arthritis presents with a sore throat, fever, and dependent edema. The patient had been in good health previously. A complete blood count reveals a white count of 500 (normal, 5,000–8,000). Drugs capable of causing this effect include

(1) aspirin
(2) indomethacin
(3) sulindac
(4) phenylbutazone

SUMMARY OF DIRECTIONS

A	B	C	D	E
1, 2, 3 only	1, 3 only	2, 4 only	4 only	All are correct

23. Which of the following statements would be true of H_1 receptor blockers?

(1) They are substituted imidazoles
(2) They increase the heart rate
(3) They decrease gastric secretion
(4) They cause sedation

Questions 24 and 25

A 70-year-old woman with a history of congestive heart failure, for which she takes digoxin and a diuretic agent, is seen because of an arrhythmia. Electrolyte determination reveals a serum K^+ of 2.8 mEq/L.

24. Diuretics capable of producing this patient's hypokalemia include

(1) furosemide
(2) ammonium chloride
(3) hydrochlorothiazide
(4) aminophylline

25. Immediate therapy for this patient should include

(1) high doses of spironolactone
(2) insulin and glucose administration
(3) high doses of triamterene
(4) potassium supplementation

26. Correct statements concerning procaine include which of the following?

(1) It has an ester linkage
(2) It interferes with sodium influx during depolarization
(3) It is relatively short-acting
(4) It produces a lupus-like syndrome

27. A 67-year-old male presents with acute pulmonary coccidioidomycosis. Proper therapy would include

(1) high doses of penicillin G
(2) griseofulvin
(3) flucytosine
(4) amphotericin B

28. The concomitant administration of antacids with tetracycline will reduce the effectiveness of the antibiotic because

(1) antacids inhibit the absorption of tetracycline
(2) antacids stimulate the drug microsomal metabolizing system, so that the tetracycline is metabolized more rapidly
(3) ions in antacids chelate the tetracycline
(4) antacids enhance the renal excretion of tetracycline

29. Drug metabolism can be influenced by which of the following factors?

(1) Age
(2) Hepatic disease
(3) Concomitant drug therapy
(4) Apparent volume of distribution

30. Oral contraceptives containing norethindrone act basically by which of the following mechanisms?

(1) Speeding up the growth of ovarian follicles
(2) Increasing the secretion of follicle-stimulating hormone (FSH)
(3) Hastening the release of luteinizing hormone (LH)
(4) Suppressing ovulation

31. An 18-year-old woman presents with urgency, frequency, and burning urination. She is afebrile. Urinalysis reveals the presence of red blood cells. Appropriate therapy after urine culture could include which of the following?

(1) Trimethoprim-sulfamethoxazole
(2) Carbenicillin
(3) Sulfisoxazole
(4) Gentamicin

32. Characteristics of ergot alkaloids include which of the following?

(1) They are useful in treating migraine headaches
(2) They show CNS stimulating effects
(3) They can produce vasoconstriction
(4) They can be blocked by propranolol

33. Untoward effects of corticosteroids include

(1) suppression of the pituitary–adrenal axis
(2) increased susceptibility to infection
(3) behavioral disturbances
(4) muscle hypertrophy

34. Lidocaine, when used intravenously, will

(1) suppress premature ventricular contractions
(2) reverse atrial arrhythmias
(3) decrease sodium conductance in automatic cells
(4) decrease potassium conductance in automatic cells

35. True statements about the purine analog 6-mercaptopurine include which of the following?

(1) It is a structural analog of hypoxanthine
(2) It decreases the synthesis of 5-phosphoribosylamine
(3) It interferes with the formation of adenosine monophosphate
(4) Its metabolism is stimulated by allopurinol

36. Which of the following agents should not be administered to a patient whose renal function is severely compromised?

(1) Tobramycin
(2) Erythromycin
(3) Penicillin
(4) Doxycycline

37. Which of the following drugs and descriptions are correctly matched?

(1) Lidocaine—an ester but metabolized in the liver
(2) Mepivacaine—an amide metabolized in the liver
(3) Procaine—rapidly inactivated by acetylcholinesterase
(4) Tetracaine—a good spinal anesthetic

Questions 38 and 39

A patient presents with a 5-day history of a nonproductive cough, a fever of 101°F, and malaise. The chest x-ray is consistent with a diagnosis of *Mycoplasma pneumoniae* pneumonia.

38. Proper therapy could include which of the following?

(1) Doxycycline
(2) Chlortetracycline
(3) Erythromycin
(4) Streptomycin

39. Two days later the patient is re-diagnosed as having Legionnaires' disease. Correct therapy would include

(1) streptomycin
(2) doxycycline
(3) chloramphenicol
(4) erythromycin

40. Aspirin is characterized by which of the following?

(1) Its analgesic, antipyretic, and anti-inflammatory actions are due to inhibition of prostaglandin synthesis
(2) Toxic doses are capable of producing a respiratory and metabolic acidosis
(3) It can increase mean bleeding time
(4) Excretion can be increased by acidifying the urine

41. Which of the autacoids listed below will cause vasoconstriction in the microcirculation of humans?

(1) Bradykinin
(2) Angiotensin II
(3) Prostaglandin F
(4) Serotonin

42. Characteristics of carbachol (carbamylcholine) include which of the following?

(1) It is a parasympathetic agent
(2) It is purely muscarinic in action
(3) It is resistant to acetylcholinesterase
(4) It is purely nicotinic in action

43. Characteristics of antineoplastic agents include which of the following?

(1) They frequently are self-limiting in their killing of cancer cells
(2) They kill a constant fraction of the tumor cells
(3) They are preferentially toxic to nonproliferating cells
(4) They are usually used in combination with each other

44. Side effects most frequently seen with benzodiazepines include

(1) drowsiness
(2) ataxia
(3) lethargy
(4) seizures

SUMMARY OF DIRECTIONS

A	B	C	D	E
1, 2, 3 only	1, 3 only	2, 4 only	4 only	All are correct

45. Adrenocortical drugs that are anti-inflammatory in pharmacologic doses include which of the following?

(1) Desoxycorticosterone
(2) Corticotropin (ACTH)
(3) Aldosterone
(4) Cortisol (hydrocortisone)

46. Quinidine administration can produce which of the following actions on the heart?

(1) A reduction in the maximal rate of rise ($\dot{V}_{max}$) of depolarization
(2) An increase in the effective refractory period (ERP)
(3) A decrease in automaticity
(4) An increase in inotropic action

47. The properties of carrier-mediated facilitated diffusion include which of the following?

(1) The process is not saturable
(2) It is specific for the chemical structure of the drug
(3) It requires energy
(4) It cannot move against a concentration gradient

48. Which of the following are true statements concerning the autacoids?

(1) Autacoids are circulating or locally active hormones from diffuse tissues
(2) All autacoids are believed to be involved with local circulatory adjustments and/or inflammation
(3) Kinins, like histamine, are associated with a "triple response"
(4) Stimulation of histamine receptors has been linked to calcium influx

49. Bleomycin is an antitumor agent that has which of the following characteristics?

(1) It intercalates with DNA
(2) It causes both single- and double-strand breaks in DNA
(3) It requires ferrous ion for its action
(4) It kills cells in G_2 and M phase

50. A patient presents with respiratory failure, pinpoint pupils, and cardiovascular collapse. The drugs which might reverse these symptoms include which of the following?

(1) Digoxin
(2) Nalorphine
(3) Epinephrine
(4) Naloxone

51. A poorly controlled diabetic patient is complaining of hunger, diaphoresis, and palpitations. Examination also reveals a "thready" pulse. Which of the following can be deduced from her symptoms?

(1) The patient is approaching a diabetic coma
(2) Her insulin dose is probably too high
(3) She is probably "spilling" sugar in her urine
(4) Her symptoms are premonitory of insulin shock

52. Diisopropyl fluorophosphate (DFP) increases which of the following effects?

(1) Lacrimation
(2) Salivation
(3) Muscle twitching
(4) Bronchodilation

Directions: The groups of questions below consist of lettered choices followed by several numbered items. For each numbered item select the **one** lettered choice with which it is **most** closely associated. Each lettered choice may be used once, more than once, or not at all.

Questions 53–56

For each description that follows, select the drug most likely to be associated with it.

(A) Halothane
(B) Diethyl ether
(C) Nitrous oxide
(D) Isoflurane
(E) Thiopental

53. Given intravenously and not adequate for prolonged surgery

54. Has the highest minimum alveolar concentration (MAC) value

55. Highly explosive agent

56. Widely used inhalation agent that can cause liver necrosis

Questions 57–60

For each of the following diuretic agents, choose the anatomic site in the renal nephron where the principal action of the agent occurs.

(A) Glomerulus
(B) Proximal tubule
(C) Ascending limb of the loop of Henle
(D) Distal tubule
(E) Collecting duct

57. Acetazolamide

58. Spironolactone

59. Furosemide

60. Chlorothiazide

ANSWERS AND EXPLANATIONS

1. The answer is E. *(Chapter 11, II E 5; III D 5; IV E, F 5; V B 2, 4)* Tamoxifen is a nonsteroidal antiestrogen which competes with estrogen for the cytoplasmic estrogen receptor. Tumors with many estrogen receptors are frequently dependent on estrogen for cell proliferation. Thus, tamoxifen blocks the growth of such tumors. Bleomycin, mitomycin, and vinblastine are natural products that have little activity against breast carcinomas. Dacarbazine (DTIC) is a triazene alkylating agent which is effective against melanomas but is not effective against breast carcinomas.

2. The answer is B. *(Chapter 2, VI B)* Scopolamine is a competitive muscarinic blocker and therefore most closely resembles atropine in its mechanism of action. It is more potent than atropine in decreasing bronchial, salivary, and sweat gland secretions, in its sedative effect, and in producing mydriasis and cycloplegia. It is less potent than atropine in its effects on the heart, bronchial muscle, and intestines.

3. The answer is E. *(Chapter 10, I C 3 a)* Cardiovascular function is usually maintained when physiologic doses of glucocorticoids are given. This is probably so because glucocorticoids have the ability to potentiate norepinephrine. Physiologic doses of glucocorticoids can result in all of the other changes listed in the question.

4. The answer is A. *(Chapter 5, V A 3, B, C 2 b, 3 c)* Minoxidil is reserved for the treatment of moderate to severe hypertension. It is used in combination with a β-adrenergic blocking agent and a diuretic to minimize the dosage requirement. All of the other statements in the question are correct basic considerations for the treatment of hypertension.

5. The answer is D. *(Chapter 1, VIII E)* In physiologic antagonism, both agonists may have intrinsic activity; the agonist and the antagonist, however, act upon different receptors. In pharmacologic antagonism, the agonist has intrinsic activity but the antagonist has little or no intrinsic activity. Partial antagonists, such as nalorphine, possess some intrinsic activity.

6. The answer is A. *(Chapter 11, IV F 5 b (5))* Vincristine is far superior to vinblastine in the treatment of lymphocytic leukemia. When combined with prednisone, it is the treatment of choice for inducing remission in acute lymphoblastic leukemia in children.

7. The answer is C. *(Chapter 9, X A 3 a)* Rapid lympholysis produces large quantities of uric acid via nucleic acid release and catabolism. Therefore, the xanthine oxidase inhibitor allopurinol is given because it inhibits uric acid formation and thus is effective in preventing acute gouty arthritis attacks during antineoplastic therapy. Because allopurinol is an inhibitor of xanthine oxidase, it increases the renal excretion of xanthine and hypoxanthine. Since allopurinol is an analog of hypoxanthine it inhibits the metabolism of purines, not pyrimidines.

8. The answer is E. *(Chapter 13, III B 1, 4)* Mercury, like arsenic, binds to sulfhydryl groups on proteins, frequently inactivating those proteins that are enzymes, or producing structural damage. Interactions with the ferric ions of the cytochrome oxidase system is the principal mechanism of cyanide damage. Hemoglobin synthesis is disrupted by lead, which causes a microcytic hypochromic anemia. A number of substances can cause methemoglobinemia (nitrites, nitrates, chlorates, quinones), but mercury is not one of them.

9. The answer is E. *(Chapter 6, VIII B 4; Chapter 11, VI D 6; Chapter 13, II F 3)* The antitumor agent cisplatin causes severe nephrotoxicity if it is given without concomitant hydration or a diuretic. The osmotic diuretic mannitol is most commonly employed to reduce this side effect. Mannitol is also useful prophylactically to reduce the risk of acute renal failure in conditions such as cardiovascular operations and severe trauma. The other listed diuretics are not as effective as mannitol in these situations.

10. The answer is D. *(Chapter 7, II B 5)* Although iron-deficiency anemia is common during pregnancy, it is a hypochromic, microcytic anemia. A deficiency of vitamin B_{12} or intrinsic factor (or both) causes megaloblastic anemia, but is not especially likely to occur during pregnancy. Vitamin K deficiency can affect blood clotting, but does not cause an anemia. Because folic acid requirements increase during pregnancy, the most likely cause of Mrs. Jones's anemia is a folic acid deficiency.

11. The answer is E. *(Chapter 5, IV A 3 a, 8)* All of the listed untoward effects are seen except impotence. Headache usually decreases after the first few days of treatment. Dilation of cerebral vessels can result in increased intracerebral pressure. Dizziness and cerebral ischemia can be associated with

postural hypotension. When present in large amounts, nitrite ions can oxidize hemoglobin to methemoglobin.

12. The answer is D. *(Chapter 3, III C 3 e, g)* Phenytoin can exacerbate petit mal seizures. Other untoward effects include gastrointestinal irritation, ataxia and diplopia, gingival hyperplasia, hypersensitivity reactions, hirsutism, hepatitis, and drug interactions.

13. The answer is C. *(Chapter 6, VII B)* The therapeutic uses of furosemide are many, but hypocalcemia is not one of these. To the contrary, furosemide is useful for the treatment of *hyper*calcemia because it increases the renal excretion of calcium. Other clinical uses include the treatment of both acute and chronic edema from such conditions as cirrhosis, renal disease, acute pulmonary edema, and congestive heart failure.

14. The answer is A. *(Chapter 5, II H)* Digitalis glycosides have a low margin of safety. In most patients the lethal dose is likely to be only 5 to 10 times the minimal effective dose. Intoxication can be precipitated by hypokalemia, a condition that is often the result of diuretic therapy but can also be the result of protracted vomiting or diarrhea. Other signs of toxicity include abnormal color perception and, more importantly, ventricular tachycardia.

15. The answer is A. *(Chapter 1, II B 1 c (4))* After oral administration, a drug is absorbed in the intestine and then passes through the liver. Some drugs (e.g., propranolol) can undergo extensive hepatic metabolism before reaching the site of action. With most other routes of administration, this first-pass effect does not occur because extensive hepatic passage immediately after drug absorption is avoided.

16. The answer is E. *(Chapter 2, VI A 1, 4 f)* Atropine is both a central and a peripheral muscarinic blocker. Atropine competes reversibly with acetylcholine at muscarinic receptors, antagonizes the action of acetylcholine in the central nervous system, and, at high levels, blocks acetylcholine action at ganglionic synapses and motor nerve endings.

17. The answer is D. *(Chapter 6, IV B, C)* The carbonic anhydrase inhibitor acetazolamide, although a weak diuretic, is useful in the treatment of glaucoma and petit mal epilepsy. The high-ceiling diuretics, namely ethacrynic acid and furosemide, the thiazide diuretic chlorothiazide, and the postassium-sparing diuretic spironolactone are not effective agents in the treatment of glaucoma or epilepsy, although they are more effective as diuretics.

18. The answer is C. *(Chapter 3, IX F)* Pentazocine produces less nausea than other opioids, and shows a correlation between dose, analgesic potency, and depressant potency. It can cause constipation like other narcotics, and tolerance to the analgesic effect can occur. Pentazocine can cause an increase in cardiac work by increasing pulmonary and peripheral vascular resistance.

19. The answer is C. *(Chapter 5, II H 3; Chapter 6, IX B; Chapter 13, III D)* Reduction in serum potassium levels (hypokalemia) is an extremely common untoward effect of most diuretics. Hypokalemia greatly increases the potential for digitalis-induced cardiac arrhythmias. The potassium-sparing diuretics, such as spironolactone, do not produce hypokalemia and thus do not add to the toxic potential of digitalis.

20. The answer is C. *(Chapter 3, IX C 1, 4)* Heroin has a more rapid onset of action than morphine. Tolerance and dependence occur frequently with both opioids. Morphine increases biliary tract pressure by causing constriction at the sphincter of Oddi. When administered to a pain-free person morphine can produce dysphoria. It has a stimulatory effect on the chemoreceptor trigger zone, producing nausea or vomiting.

21. The answer is B (1, 3). *(Chapter 12, XI C, H; XII A, C)* Both piperazine and pyrantel pamoate are effective in the treatment of ascariasis. Metronidazole is useful in the treatment of protozoal and anaerobic bacterial infections, while suramin is useful in the treatment of trypanosomiasis and onchoceriasis.

22. The answer is D (4). *(Chapter 9, II B 6; IV B 1, 3; V B 3; VI B)* Phenylbutazone, by directly affecting the renal tubules, can cause significant salt and water retention, leading to edema. Phenylbutazone can cause agranulocytosis or aplastic anemia. Although indomethacin also can cause blood dyscrasias, its salt-retaining properties are much less significant than with phenylbutazone. The properties of sulindac are similar to those of indomethacin.

23. The answer is D (4). *(Chapter 8, III A 1)* Most H_2 receptor blockers are substituted imidazoles; H_1 receptor blockers are substituted ethylamines. H_1 blockers have minimal cardiac effects. As a class the

H_1 blockers do not alter gastric secretion, since this is primarily mediated by H_2 receptors. H_1 blockers are, however, capable of producing unpleasant sedation.

24. The answer is B (1, 3). *(Chapter 6, VI D 1; VII D 1)* Hypokalemia is a potential complication of both furosemide and hydrochlorothiazide therapy. If a patient is concurrently receiving digoxin therapy, aggravated toxicity of this cardiac glycoside can become a major therapeutic problem. Correcting the hypokalemia is essential.

25. The answer is D (4). *(Chapter 6, VI D 1; IX A 2, B 2 a)* Both spironolactone and triamterene are used as adjunct diuretics for preventing hypokalemia, but they are not used for the treatment of hypokalemia once it occurs. Insulin and glucose are used for the treatment of hyperkalemia. Immediate potassium supplementation with oral preparations is indicated.

26. The answer is A (1, 2, 3). *(Chapter 4, II A 3, C 2)* Procaine is a diethylaminoethanol ester and paraaminobenzoic acid. It does interfere with sodium influx during depolarization. It has a short duration of action and is metabolized by pseudocholinesterase. Unlike procainamide, procaine does not cause a lupus-like syndrome.

27. The answer is D (4). *(Chapter 12, IX B 5)* Amphotericin B is effective in the treatment of acute pulmonary coccidioidomycosis. The other agents listed would be ineffective. Griseofulvin is used for mycotic diseases of the skin, hair, and nails. Flucytosine is used for systemic infections caused by *Candida albicans* or *Cryptococcus meningitidis*. Penicillin G has no antifungal activity.

28. The answer is B (1, 3). *(Chapter 13, II C 2 b)* Antacids inhibit the absorption of tetracycline because ions such as aluminum in antacids can chelate the tetracycline. Antacids do not stimulate or inhibit the drug microsomal metabolizing system, nor do they enhance the renal excretion of tetracycline.

29. The answer is A (1, 2, 3). *(Chapter 1, VI C)* Factors known to affect drug metabolism in humans include the chemical properties of the drug; the dose; the route of administration; concomitant drug therapy; the patient's genetic makeup, age, gender, and diet; circadian rhythms; and the presence of significant disease. No direct relationship between the apparent volume of distribution and drug metabolism has been established.

30. The answer is D (4). *(Chapter 10, II A, B)* Oral contraceptives interfere with pituitary function by blocking the surge of luteinizing hormone (LH) and follicle-stimulating hormone (FSH) that normally occurs in the middle of the menstrual cycle. In this way, they suppress ovulation and ovarian follicle growth.

31. The answer is B (1, 3). *(Chapter 12, II E 1)* The major indication for the use of sulfa drugs is in the treatment of acute uncomplicated urinary tract infections. Carbenicillin and gentamicin represent very broad-spectrum therapy, which is unnecessary for the treatment of an uncomplicated cystitis.

32. The answer is A (1, 2, 3). *(Chapter 2, III A 4)* Ergot alkaloids, by directly stimulating vascular smooth muscle, are useful in treating migraine headaches. Their chemical structure resembles LSD and thus CNS stimulation can occur. Ergot alkaloids are weak α-blockers and therefore would not be blocked by propranolol.

33. The answer is A (1, 2, 3). *(Chapter 10, I C 9)* Corticosteroids, especially when used for long periods, can result in all of the untoward effects listed in the question except for muscle hypertrophy. Rather, a myopathy can occur which is characterized by proximal arm and leg weakness.

34. The answer is B (1, 3). *(Chapter 4, II A 1-3, C 4 d, Chapter 5, III E 3)* Lidocaine is an effective antiarrhythmic agent and is the drug of choice for premature ventricular contractions, although it is ineffective in atrial arrhythmias. It decreases sodium but not potassium conductance in automatic cells.

35. The answer is A (1, 2, 3). *(Chapter 11, III C 1)* Allopurinol blocks rather than stimulates the metabolism of 6-mercaptopurine. In addition, allopurinol blocks the formation of uric acid from hypoxanthine and xanthine. All of the other statements about 6-mercaptopurine in the question are correct.

36. The answer is B (1, 3). *(Chapter 12, III E 2, H 2 b; V C 2 b, V F 1 g (2); VIII D 1 d)* In a patient with renal disease, any antibiotic which is renally excreted should be administered with caution. Penicillin and tobramycin are two such antibiotics. Both erythromycin and doxycycline (in contrast to other tetracyclines) are excreted in the bile and feces; thus, they are useful in the treatment of infections in renally compromised patients.