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MULTIPLE CHOICE

1. The pharmacokinetic phases control the _____ of the drug's effect and the _____ of the drug action.
   a. intensity, duration
   b. duration, effect
   c. mechanism, safety
   d. length, efficacy

   ANS: A
   As a drug moves throughout the body, it undergoes changes that may increase or decrease its absorption, distribution, metabolism, or elimination. These pharmacokinetic phases control the intensity (how much is absorbed and therefore distributed) of the drug's effect and the duration (how fast it is metabolized and eliminated) of the drug action.

   DIF: Cognitive level 2: Comprehension REF: p. p0215 OBJ: 2

2. The time it takes for a drug to reach the concentration necessary to produce a therapeutic effect is called the _____ of action.
   a. duration
   b. mechanism
   c. onset
   d. length

   ANS: C
   The length of time it takes for drug action to begin after a dose is administered is called the *onset* of action. The onset of action is not achieved until the drug reaches the minimum concentration in the body needed to produce drug action. The duration of action is the time between the onset of action and discontinuation of drug action. The duration of action is the amount of time (length/time) the drug concentration remains within the therapeutic range. The mechanism of action refers to the specific biochemical interaction through which a drug substance produces its pharmacological effect, the time in which it produces the effect.

   DIF: Cognitive level 1: Recall REF: p. p0225 OBJ: 8

3. Duration of action is the time between the _____ of action and _____ of drug action.
   a. mechanism, duration
   b. onset, discontinuation
   c. duration, concentration
   d. onset, mechanism

   ANS: B

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The duration of action is the time between the *onset* of action and *discontinuation* of drug action. The duration of action is the amount of time (length/time) the drug concentration remains within the therapeutic range. The mechanism of action refers to the specific biochemical interaction through which a drug substance produces its pharmacological effect (the how), the time in which it produces the effect. The length of time it takes for drug action to begin after a dose is administered is called the onset of action. The onset of action is not achieved until the drug reaches the minimum concentration in the body needed to produce drug action; this is when the drug begins its effects beginning the duration of action.

DIF: Cognitive level 1: Recall REF: p. p0225 OBJ: 8

4. Which of the following factors will determine how quickly or slowly a drug is absorbed?
   a. Ionization of the drug
   b. Kidney disease
   c. Half-life of the drug
   d. Drug dosage form

   ANS: D
   How quickly or slowly a drug is absorbed is determined by the characteristics of the drug, drug dosage form, route of administration, and human anatomy and physiology. All other factors listed are factors influencing elimination of a drug.

   DIF: Cognitive level 2: Comprehension REF: p. p0230 OBJ: 2

5. Which of the following doses has 100% bioavailability?
   a. 1 mL PO
   b. 2 mL IV
   c. 1 tablet PO
   d. 1 supp pr

   ANS: B
   The bioavailability of a drug is influenced by drug absorption, the first-pass effect, and distribution to the site of action. Drugs that are administered intravenously are completely absorbed into the bloodstream if they are injected directly into the vein. The first-pass effect is a process whereby only a *fraction* of an *orally* (PO) administered drug reaches systemic circulation. This prevents complete absorption of the drug into the bloodstream. Rectal dose forms are transmucosal and therefore need to cross a membrane before entering the bloodstream and not completely absorbed.

   DIF: Cognitive level 3: Application REF: p. p0460 OBJ: 2 | 3 | 7

6. The ability of a drug to diffuse across the cell membrane is dependent upon _____ of the drug and the _____ of the body fluid in which it is dissolved.
   a. properties, actions
   b. pH, actions
   c. properties, pH
   d. strength, health

   ANS: C

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The ability of a drug to diffuse across the cell membrane is dependent upon *properties* of the drug and the *pH* of the body fluid in which it is dissolved; not vice versa. The strength of the drug is determined by the amount that will be absorbed and it therefore offered in varied strengths due to this and the amount to produce an effect. The health of an individual can also affect absorption, but dosage can be adjusted accordingly because of this.

DIF: Cognitive level 2: Comprehension REF: p. p0260 OBJ: 2

7. What could be done to increase absorption of an intramuscular injection?
   a. Cry because the injection hurt.
   b. Apply a cold pack.
   c. Take a nap.
   d. Exercise the muscle.

   ANS: D
   Absorption of drugs that are injected intramuscularly or subcutaneously is enhanced when the patient applies heat to the muscle, exercises, or does some other activity to stimulate blood flow to the site of administration. Crying, applying a cold pack, and taking a nap do not stimulate blood flow to the site of administration.

   DIF: Cognitive level 3: Application REF: p. p0270 OBJ: 2

8. What would be a benefit to a drug that is hydrophobic and nonionized?
   a. The drug would cause fewer side effects.
   b. The drug would easily be metabolized by the body.
   c. The drug would easily be distributed throughout the body.
   d. There would be no benefit.

   ANS: C
   Distribution of the drug across the cell membrane of the blood vessel and transport to its site of action is influenced by the chemical nature of the drug. The drug must be hydrophobic, lipid soluble, nonionized, or small enough to pass through slit junctions in the capillary wall; which has a benefit. The drug being hydrophobic and nonionized does not affect metabolism only distribution. It will also not have an effect on side effects; side effects vary person to person.

   DIF: Cognitive level 4: Analysis REF: p. p0325 OBJ: 2

9. What would be the potential result of dispensing two drugs that are both weak acids and are hydrophobic?
   a. Easy elimination of each drug because they are hydrophobic
   b. Drug interaction
   c. Easy ionization of each drug
   d. Drug hypersensitivity

   ANS: B
   Albumin has the greatest affinity for weak acids and hydrophobic drugs. Competitive protein binding represents a mechanism for drug interactions. Being hydrophobic affects distribution and not elimination. Ionization also effects elimination not distribution. Drug hypersensitivity is based on the individual not the drug being a weak acid or hydrophobic.

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DIF: Cognitive level 4: Analysis REF: p. p0330 OBJ: 2

10. Which of the following allows for the greatest absorption of an orally administered drug?
    a. Small intestine
    b. Large intestine
    c. Liver
    d. Spleen

    ANS: A
    Absorption of orally administered drugs is greatest in the small intestine. The structure of the intestine is designed to perform the specialized job of absorption. Thousands of microvilli line the walls of the small intestine. The microvilli are filled with blood vessels. As the drug passes through the cell membrane of the microvilli, it is quickly absorbed into the bloodstream. The large intestine does not have microvilli to help absorb drugs, but have a thick mucosal lining and mucous secreting glands to help pass feces. The liver affects metabolism and distribution and not absorption, while the spleen affects distribution.

    DIF: Cognitive level 2: Comprehension REF: p. p0270 OBJ: 2

11. Distribution of the drug across the cell membrane of the blood vessel and transport to its site of action is influenced by the _____ nature of the drug.
    a. physical
    b. mechanical
    c. chemical
    d. enzyme

    ANS: C
    Distribution of the drug across the cell membrane of the blood vessel and transport to its site of action is influenced by the *chemical* nature of the drug; i.e., lipid soluble, nonionized, etc. Physical (how it relates to the body) nature and mechanical (how it works or is applied) nature relate more to how it gets into the body rather than distributed. Enzymes will affect metabolism and not distribution.

    DIF: Cognitive level 2: Comprehension REF: p. p0325 OBJ: 2

12. Which of the following is *not* a major site of drug elimination?
    a. Lungs
    b. Kidney
    c. Liver
    d. Bowel

    ANS: C
    The three major routes of drug elimination are the kidney, lung, and bowel. The liver, skin, eyes, mouth, nose, penis, and breast are *minor* routes (Table 2-3).

    DIF: Cognitive level 2: Comprehension REF: p. p0425 OBJ: 5

13. _____ are drugs that are administered in an inactive form and must be metabolized to their active form.
    a. Metabolites
    b. Prodrugs

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c. Lipophilics
d. Hydrophobics

ANS: B
Prodrugs are drugs that are administered in an inactive form and must be metabolized to their active form. Metabolites are a product of drug metabolism. Lipophilics have an affinity for lipids, lipid loving. Hydrophobics lack an affinity for water, water hating.

DIF: Cognitive level 1: Recall REF: p. p0360 OBJ: 8

14. _____ and _____ require lower doses of drug to produce therapeutic effects.
a. Infants, the elderly
b. Teenagers, the elderly
c. Children, adults
d. Infants, children

ANS: A
Infants and the elderly require lower doses of drug to produce therapeutic effects. Metabolism in the liver is decreased in elderly adults and in infants. Age-related changes in the liver decrease metabolic enzyme function in elderly adults. Metabolizing enzyme systems (cytochrome P-450 system [CYP450]) are not fully developed in infants; therefore, their ability to metabolize drugs is decreased. Teenagers and adults have fully developed CYP-450 system and do not have the effects of decreased liver enzymes.

DIF: Cognitive level 2: Comprehension REF: p. p0385 OBJ: 2

15. Of the following doses, which would have a longer half-life?
a. One tablet every day
b. One tablet twice daily
c. One tablet three times a day
d. One tablet four times a day

ANS: A
Drugs with a long half-life are dosed less frequently than are drugs with a very short half-life. A once daily dosing is less frequent than twice, thrice, and four times daily.

DIF: Cognitive level 3: Application REF: p. p0455 OBJ: 6

16. What could be a benefit of a nonionized drug when being eliminated?
a. The liver would not be able to release the necessary metabolizing enzymes.
b. It would be reabsorbed into circulation to prolong its effects.
c. It would be easily eliminated from circulation through the urine.
d. It would not be subject to the “first-pass effect.”

ANS: B

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Changes in the acidity of the urine can influence the rate in which a drug is cleared from the body. Drugs that are ionized are eliminated in the urine. Nonionized drugs are reabsorbed into the circulatory system to continue their drug action (effects), which allows for more drug to stay in the system and possibly reducing the dosing and quantity of drug taken. Being ionized or nonionized does affect the first-pass effect. Nonionized drugs easily go back into circulation by diffusing out of the nephron, not easily eliminated from circulation through the urine. Being a nonionized drug would not inhibit the liver from releasing necessary enzymes, but may have an effect on whether the enzyme can do its job.

DIF: Cognitive level 4: Analysis REF: p. p0440 OBJ: 2

17. If a prescriber wanted a basic drug to not easily be eliminated from circulation, he or she could prescribe which of the following concurrently?
    a. Sodium bicarbonate
    b. Sodium chloride
    c. Vitamin C
    d. Vitamin B_3

    ANS: A
    Urinary alkalinizers (e.g., bicarbonate) decrease the elimination of basic drugs. Sodium chloride and Vitamin B_3 have a pH close to the pH of the human body and therefore would not be good at decreasing the elimination of basic drugs. Vitamin C would acidify urine and decrease the elimination of *acidic* drugs not basic drugs.

    DIF: Cognitive level 3: Application REF: p. p0450 OBJ: 2

18. Why is the route of administration important to the "first-pass effect"?
    a. The route can help determine if the drug is being taken as prescribed and therefore is overcoming the first-pass effect.
    b. A drug can be significantly reduced to its inactive metabolite before first entering circulation when administered orally.
    c. Drugs administered parenterally are highly subject to the first-pass effect and should therefore be dosed accordingly.
    d. Bioavailability of drug can be greatly reduced when the drug is administered by a route other than orally.

    ANS: B
    Orally administered drugs must pass into hepatoportal circulation (liver) before entering into the general circulation. The *first-pass effect* describes a process whereby the liver metabolizes nearly all of a drug to an inactive metabolite before it passes into the general circulation. The route is important because it will depend on how much drug enters the body; how fast it is absorbed, metabolized, distributed, and eliminated. Oral routes will always go through the liver and therefore subject to the first-pass effect. Other routes enter the bloodstream in a different way initially bypassing the liver. If the drug is being taken as prescribed, it has no bearing on the first-pass effect, only the route in which it is taken.

    DIF: Cognitive level 4: Analysis REF: p. p0365 OBJ: 3

19. Which of the following would be classified as pharmaceutical alternatives for Procardia (nifedipine)?
    a. Procardia 10-mg capsules vs. nifedipine 10-mg capsules

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b. Nifedipine 20-mg gel capsules vs. Procardia 20-mg gel capsules
c. Procardia 10-mg capsules vs. Procardia XL 30-mg tablets
d. Nifedipine XL 30-mg capsules vs. Procardia XL 30-mg capsules

ANS: C
Pharmaceutical alternatives contain the same active ingredient as the brand name product; however, the strength and dosage form may be different. Procardia 10-mg capsules vs. nifedipine 10-mg capsules, Nifedipine 20-mg gel capsules vs. Procardia 20-mg gel capsules, and Nifedipine XL 30-mg capsules vs. Procardia XL 30-mg capsules are examples of bioequivalent drugs.

DIF: Cognitive level 2: Comprehension REF: p. p0465 OBJ: 7

20. Why would the warning label "Do not take with grapefruit juice" need to be added to a prescription for lovastatin?
a. The drug should be taken on an empty stomach.
b. The drug effect would be increased as a result of inhibition of necessary metabolic enzymes.
c. The drug effect would be decreased as a result of an increased release of metabolic enzymes.
d. The drug is not able to produce its effects because the juice inactivates it.

ANS: B
Grapefruit juice is an inhibitor of the metabolic enzyme CYP3A4. When drugs that have a CYP3A4 substrate, such as the anticholesterol drug lovastatin, are taken with grapefruit juice, metabolism is reduced and blood levels of the drugs are increased along with drug effects. It increases (not decreases) the effects not because the juice inactivates or because there is an increased metabolic enzymes, but because the juice inhibits the metabolic enzyme from doing its job. Lovastatin immediate-release tablets should be taken with the evening meal.

DIF: Cognitive level 4: Analysis REF: p. p0410 OBJ: 2

21. Using the following table, determine what the drug concentration (X) would be 40 hours after peak concentration.

Different perspectives	**Changing values**					
Drug concentration (mg/L)	100	50	25	12.5	6.25	**X**
Hours after peak concentration	0	8	16	24	32	40
Number of half-lives	0	1	2	3	4	5
Percentage of drug removed	0	50	75	88	94	97

a. 0 mg/L
b. 2.08 mg/L
c. 3.125 mg/L
d. 4.17 mg/L

ANS: C

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Elimination half-life ($t_{1/2}$) refers to the time it takes for 50% of the drug to be cleared from the bloodstream. It takes approximately eight half-lives to eliminate a drug entirely from the body. After 40 hours, the drug concentration will be half of what it was 8 hours before (at 32 hours). So, 6.25/2 = 3.125 mg/L – half the drug concentration from before. Following the same logic, the concentration at 48 hours would be 1.5625 mg/L. For the drug concentration to be 0 mg/L at 40 hours the drug concentration at 32 hours would have to be 0 mg/L, for the drug concentration to be 2.08 mg/L at 40 hours the drug concentration at 32 hours would have to be 4.16 mg/L, and for the drug concentration to be 4.17 mg/L at 40 hours the drug concentration at 32 hours would have to be 8.34 mg/L.

DIF: Cognitive level 3: Application REF: p. p0455 OBJ: 6

22. The prescriber has written a prescription for Lopressor 100 mg. Which of the following generic medications can you dispense?
    a. Metoprolol tartrate 100 mg
    b. Labetalol hydrochloride 100 mg
    c. Metoprolol succinate 100 mg
    d. Atenolol 100 mg

    ANS: A
    Metoprolol tartrate should be dispensed as a generic (bioequivalent) drug. Metoprolol succinate 100 mg would be a pharmaceutical equivalent because the salt succinate is different than the salt tartrate. Labetalol hydrochloride 100 mg and Atenolol 100 mg would be therapeutic alternatives. When not dispensing a bioequivalent drug, prescriber authorization is needed.

    DIF: Cognitive level 3: Application REF: p. p0465 OBJ: 7

23. Which of the following is *not* true about the blood-brain barrier?
    a. The blood-brain barrier is composed of cells lining the capillaries of the brain that form tight junctions.
    b. It is a natural body barrier that limits the access to the site of drug action.
    c. They permit passage of lipid-insoluble, hydrophobic drugs into the brain and limit access of non-ionized hydrophilic drugs.
    d. The blood vessels in the brain are also surrounded by fatty structures called glial feet which limit the passage of ions between the capillaries and brain tissue.

    ANS: C
    Natural body barriers may limit access to the site of drug action. The anatomical structures that selectively limit drug access are the blood-brain barrier, blood-placenta barrier, and blood-testicular barrier. The blood-brain barrier is composed of cells lining the capillaries of the brain that form tight junctions. The blood vessels in the brain are also surrounded by fatty structures called glial feet (also known as astrocyte foot processes). These structures limit the passage of ions between the capillaries and brain tissue. They permit passage of *lipid-soluble*, hydrophobic drugs into the brain and limit access of *ionized* hydrophilic drugs.

    DIF: Cognitive level 2: Comprehension REF: p. p0335 OBJ: 4

24. The process involving the movement of drug molecules from the site of administration into the circulatory system is known as _____.
    a. bioavailability

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b. metabolism
c. diffusion
d. absorption

ANS: D
Absorption is the process involving the movement of drug molecules from the site of administration into the circulatory system. Bioavailability is the fraction of an administered dose that enters the systemic circulation in an unchanged form and is available to produce its effects. Metabolism is the Biochemical process involving transformation of active drugs to a compound that can be easily eliminated, or the conversion of prodrugs to active drugs. Diffusion is the passive movement of molecules across cell membranes from an area of high drug concentration to lower concentration.

DIF: Cognitive level 1: Recall REF: p. p0230 OBJ: 1

25. _____ is the second pharmacokinetic phase which is the process of movement of the drug from the circulatory system across barrier membranes to the site of drug action.
a. Absorption
b. Distribution
c. Metabolism
d. Elimination

ANS: B
Distribution is the process of movement of the drug from the circulatory system across barrier membranes to the site of drug action. It is the second pharmacokinetic phase. ***Absorption*** is the first pharmacokinetic phase and is the process that involves the movement of drug molecules from the site of administration, across cell membranes, and into the circulatory system of the body (blood or lymphatic system). Metabolism is the third phase is the biochemical process involving transformation of active drugs to a compound that can be easily eliminated, or the conversion of prodrugs to active drugs. Elimination is the last phase which is the process that results in the removal of drug from the body.

DIF: Cognitive level 1: Recall REF: p. p0290 OBJ: 1

26. The process of drug metabolism in the body that transforms a drug to a more active, equally active or inactive metabolite is known as _____.
a. biotransformation
b. first-pass effect
c. distribution
d. ionization

ANS: A
Biotransformation is the process of drug metabolism in the body that transforms a drug to a more active, equally active, or inactive metabolite. **First-pass effect is the p**rocess whereby only a fraction of an orally administered drug reaches systemic circulation because much of the drug is metabolized in the liver to an inactive metabolite before entering the general circulation. **Distribution is the p**rocess of movement of the drug from the circulatory system across barrier membranes to the site of drug action. **Ionization is the c**hemical process involving the gain or release of a proton (H+).

DIF: Cognitive level 1: Recall REF: p. p0350 OBJ: 1 | 8

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27. Which of the following is the final pharmacokinetic phase which results in removal of the drug from the body and discontinuation of drug action?
    a. metabolism
    b. absorption
    c. elimination
    d. distribution

    ANS: C
    Elimination is the final pharmacokinetic phase. Elimination results in removal of the drug from the body and discontinuation of drug action. ***Absorption*** is the first pharmacokinetic phase and is the process that involves the movement of drug molecules from the site of administration, across cell membranes, and into the circulatory system of the body (blood or lymphatic system). ***Distribution*** is the process of movement of the drug from the circulatory system across barrier membranes to the site of drug action. It is the second pharmacokinetic phase. Metabolism is the third phase is the biochemical process involving transformation of active drugs to a compound that can be easily eliminated, or the conversion of prodrugs to active drugs.

    DIF: Cognitive level 1: Recall REF: p. p0425 OBJ: 1

TRUE/FALSE

1. The body has to metabolize drugs before they are eliminated.

    ANS: T
    The body metabolizes the drug, and then it is eliminated.

    DIF: Cognitive level 1: Recall REF: p. p0215 OBJ: 2

2. Drugs that are administered orally are completely absorbed into the bloodstream.

    ANS: F
    Drugs that are administered *intravenously* are completely absorbed into the bloodstream because they are injected directly into the vein (bloodstream). The first-pass effect is a process whereby only a *fraction* of an *orally* administered drug reaches systemic circulation. This prevents complete absorption of the drug into the bloodstream.

    DIF: Cognitive level 2: Comprehension REF: p. p0365 | p. p0460
    OBJ: 2 | 3

3. A drug that is highly lipophilic will have difficulty moving across a membrane.

    ANS: F
    Lipid-soluble drugs *readily diffuse* across the cell membrane of the blood vessel into the bloodstream. Lipid-soluble drugs are ***lipophilic*** (lipid loving).

    DIF: Cognitive level 2: Comprehension REF: p. p0240 OBJ: 2

4. Passive transport takes energy and requires special carrier proteins or pumps so that the drug can be carried across the cell membrane.

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ANS: F
Active transport takes energy and requires special carrier proteins or pumps to "carry the drug" across the cell membrane. Drugs that are absorbed by passive diffusion (transport) move from a region of greater concentration to a region of lesser concentration, lipophilic and hydrophilic drugs.

DIF: Cognitive level 1: Recall REF: p. p0245 OBJ: 2

5. Absorption is greatest when the body has a good blood supply in the area where the drug is to be absorbed.

ANS: T
Absorption is greatest in areas of the body that have good blood supply; drugs cannot produce their intended effects until they reach the blood supply.

DIF: Cognitive level 1: Recall REF: p. p0270 OBJ: 2

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