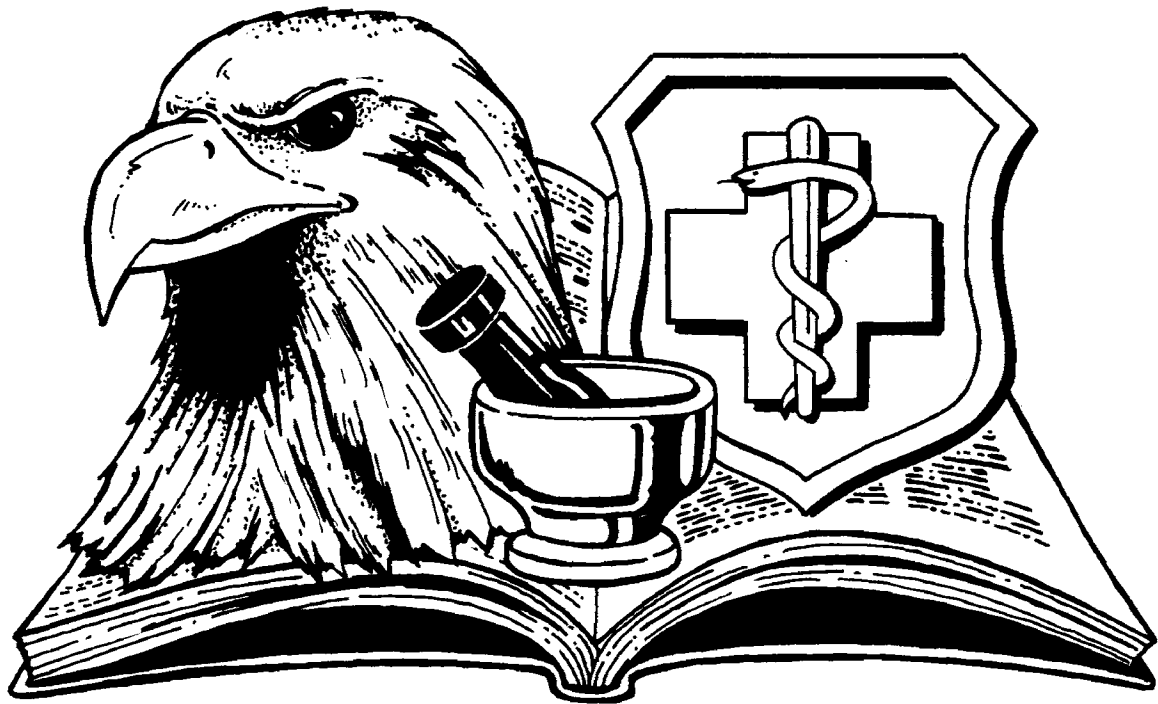


CDC 4P051B

Pharmacy Journeyman

**Volume 1. Pharmaceutical
Dispensing, Terminology, Anatomy
and Physiology**



Extension Course Institute

Air University

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Career Development Course 4P051B, *Pharmacy Journeyman*, is designed to satisfy the 5-skill level CDC subject and task knowledge requirements specified in the Specialty Training Standard. The course is five volumes long and is set up as follows:

This first volume, *Pharmaceutical Dispensing, Terminology, Anatomy and Physiology*, starts off with information about dispensing. The section covering outpatient dispensing discusses how to receive, interpret, and dispense a prescription properly. This volume also covers the very important task of patient counseling—plus a section on investigational drugs. The inpatient section discusses different types of inpatient drug distribution and some of the equipment used to to accomplish this distribution. Volume 1 then has a section on medical and pharmaceutical terminology and abbreviations. A brief discussion of apothecary terms is included. Next, there is a section on drug delivery systems, actions and uses, and basic biopharmaceutics. Wrapping up volume 1, you'll find a unit devoted to a brief overview/introduction to the human body. This final unit will prepare you for the rest of the course.

Volumes 2, 3, and 4, *Anatomy, Physiology, and Pharmacology*, sections 1,2, and 3, respectively, will give you information about a system within the human body. This is followed by a discussion of the different disease states that could effect that particular system. Drug therapy is also covered for the disease states. This information is laid out in a pattern that should be very familiar to you. There is 10 systems covered: the integumentary system, the skeletal system, the muscular system, the nervous system, the endocrine system, the circulatory system, the respiratory system, the digestive system, urinary system, and reproductive system.

Volume 5, *Drug Therapies in Non-Disease States, Miscellaneous Drug Therapies, Emergency Drugs, and Toxicology*, discusses pretty much what the name implies, with an added section covering herbal remedies.

There is no glossary in the back of each volume. The glossary has been published as a separate booklet, and should be included in your CDC package.

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To get an *immediate response* to your questions concerning subject matter in this course, call the author at DSN 736-3237 between 0730 and 1630 (CT), Monday through Friday. You may e-mail the author at donald.pearson@sheppard.af.mil. Otherwise, write the author at 382 TRS/XYAD, ATTN: MSgt Don Pearson, 917 Missile Rd, Ste 3, Sheppard AFB, TX 76311 to point out technical errors you find in the text, unit review exercises, or course examination. Sending subject matter questions

NOTE: Do not use the IDEA Program to submit corrections for printing or typographical errors.

Consult your education officer, training officer, or NCOIC if you have questions on course enrollment or administration, *Your Key to a Successful Course*, and irregularities (possible scoring errors, printing errors, etc.) on the unit review exercises and course examination. Send questions these people cannot answer to OAS/EIO, 50 South Turner Blvd, Maxwell AFB, Gunter Annex AL 36118–5643, on ECI Form 17, Student Request for Assistance.

This volume is valued at 21 hours and 7 points.

Acknowledgment

Cover artwork for this volume, *Air Force Pharmacy, A Proud Heritage*, was originally designed by SrA Shirley Mack, 55th MDSS, Offutt AFB, Nebraska.

NOTE:

In this volume, the subject matter is divided into self-contained units. A unit menu begins each unit, identifying the lesson headings and numbers. After reading the unit menu page and unit introduction, study the section, answer the self-test questions, and compare your answers with those given at the end of the unit. Then do the unit review exercises.

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Unit 1. Pharmaceutical Dispensing

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DISPENSING is the very visible part of your daily duties. It requires professionalism, knowledge of directives, and adherence to appropriate procedures. Dispensing, in one form or another, is the bulk of your duties. You'll find the "meat and potatoes" of your business will be to patients in the outpatient waiting area. In fact, that's where you'll spend most of your dispensing time. At other times, you'll be tasked to dispense to patients having procedures performed in the clinic setting. This will be accomplished through bulk/clinic issues and dispensing to inpatients through the unit dose method. In this unit you'll first take a look at outpatient dispensing. Then, your attention will be turned to the characteristics of inpatient dispensing

1-1. Outpatient Dispensing

In course A, you learned a lot about pharmacy administration, chemistry, calculations, and supply issues. You read about how to use the Composite Healthcare System (CHCS). Everything's now put together, your shelves are full, and the computer is fired up. You're ready to dispense; however, before you get to the actual processing of a prescription, let's first highlight some requirements. You'll begin with receiving and interpreting a prescription.

001. Receiving and interpreting a prescription

Writing prescriptions

Those individuals authorized to prescribe drugs for individual patients in an Air Force medical facility use AF Form 781, Multiple Item Prescription, or DD Form 1289, DOD Prescription. On the AF Form 781, prescriptions must be written in ink or indelible pencil, and no more than three prescriptions may be written on one Form.

NOTE: Prescriptions for drugs listed in schedule II must be separate from those in schedules III, IV, and V. Noncontrolled drugs are NEVER written on the same form with controlled drugs.

The prescriber must make sure all patient identification data is properly completed, showing the patient's full name (and rank or grade for active duty and retired military personnel). The patient's telephone number is included on each prescription. In addition, the patient's address must be on prescriptions for controlled substances. The age of children 12 years and under must be included. The prescriber's name stamp is used on all prescriptions.

Contact the prescriber before filling a prescription that is illegible, incompatible, or if there's a question of dosage, interaction, allergy, or administration.

The prescription designates a particular medication for a particular individual at, and normally for, a particular time. In essence, the prescription represents a link between the provider, the pharmacy, and the patient. It becomes your responsibility to interpret the wishes of the prescriber to provide treatment for the patient. Therefore, when you're filling outpatient prescription be conscious of both the intent of the prescribing physician and the needs of the patient.

Sections of prescriptions

All pharmacy technicians have been exposed to different prescription styles as they perform their pharmaceutical dispensing duties. AF providers use the earlier mentioned AF Form 781. At times, you may see DD Form 1289. In contrast, prescriptions from civilian providers can come in almost any size, shape, and color.

No matter what the form, prescriptions historically have four main parts or sections. To better understand your responsibility in filling prescriptions, you need to understand the various sections of the prescription. They are as follows:

1. Superscription.
2. Inscription.
3. Subscription.
4. Signature.

Superscription

The superscription is represented by the symbol Rx, which signifies recipe. Recipe comes from the Latin word *recipere*, meaning to take.

Inscription

Inscription means “containing the ingredients.” The inscription is further broken down into these four parts:

1. Basis (principle drug).
2. Adjuvant, which assists the action of the basis.
3. Corrective, something to take away the unpleasant taste or pain.
4. Vehicle, something to hold the drug either in suspension or solution.

Amounts for all four of these parts are listed in the inscription section.

Subscription

This is the direction to the maker. In the past, pharmacists would prepare the compound in the parts the doctor ordered. As pharmacy technicians, we don’t do much of this anymore. The closest you can compare this part to would be the AF Form 2381, Pharmacy Master Formula. We consider the subscription on this form to be the amount to dispense.

Signature

Pharmacy professionals know the signature as the “sig.” We’re sure this term rings a bell to you. The sig is the directions to the patient. Your job is to interpret the sig from the prescription and label your container with appropriate directions for the patient. As a pharmacy journeyman, it’s your responsibility to properly interpret the sig and translate it for the patient.

Doctors write their sigs using Latin abbreviations, roman numerals, and sometimes their own gibberish. One thing you’ll often see (but which isn’t a satisfactory sig) is the phrase “as directed” or something similar. The table on the next page presents a listing of some of the more frequently used Latin and English prescription abbreviations and their meanings.

Receiving the prescription form from patients

Receive prescriptions from patients in a professional and dignified manner. Under no circumstances should an untrained person be allowed attempt to discuss a prescription with a patient.

A method should be established to identify the prescription with the patient and to indicate the number of prescriptions the patient should receive. In some facilities, this is done by simply writing on the top of the prescription the number of prescriptions and refills submitted. This marking will alert you as to how many total prescriptions the patient is waiting on. This method prevents you from

calling a patient prematurely and the patient possibly leaving with only part of the prescriptions submitted.

Word or phrase	Abbreviation	Meaning	Word or phrase	Abbreviation	Meaning
Ad	AD	To, up to	Oculo utro	Ou	Each eye
Agita	Agit	Shake, stir	Oculus dexter	Od	Right eye
Ana	Aa	Of each	Oculus sinister	Os	Left eye
Ante cibos	Ac	Before meals	Per os	Po	By mouth
Ante meridian	Am	Before noon, morning	Post cibos	Pc	After eating
Aqua	Aq	Water	Post meridian	Pm	Afternoon or evening
Aurio dextra	Ad	Right ear	Pro re nata	Prn	When necessary
Aurio sinister	As	Left ear	Quantum sufficiat	Qs	As much as sufficient
Auris utrae	Au	Each ear	Quantum sufficiat ad	Qs ad	A sufficient quantity to (prepare)
Bis in die	Bid	Twice a day	Quaque	Q	Each, every
Capsula	Caps	Capsule	Quaque hora	Qh	Every hour
Cum	\bar{c}	With	Quater in die	Qid	Four times a day
Dispense	Disp	Dispense	Recipe	R _x	(You) Take
Gram	G, gm, Gm	Gram	Rectal	Rect	Use rectally
Granum	Gr	Grain	Repetatur	Rept	Let it be repeated
Gutta	Gtt	A drop	Semis	Ss	One-half
Hora	H	An hour	Sine	\bar{s}	Without
Hora somni	Hs	At bedtime	Signa	Sig	(You) write
Injectio	Inj	An injection	Statim	Stat	Immediately
Intradermal	ID	Intradermal injection	Subcutaneous	Sub Q, SQ	Subcutaneous injection
Intramuscular	IM	Intramuscular injection	Suppositorium	Supp	Suppository
Intravenous	IV or iv	Intravenous injection	Suspension	Susp	Suspension
Liquor	Liq	Solution	Tabella	tab	Tablet
Microgram	Mcg	One-millionth gram	Ter id die	tid	Three times a day
Milligram	Mg	One-thousandth gram	Tablespoon	tbsp	Tablespoon
Milliliter	ml or mL	One-thousandth liter	Teaspoon	tsp	Teaspoon
Nebula	Nebul	A spray	Topically	top	(Use) topically
Nocte	Noct	At night	Unguentum	ung	Ointment
Non repetatur	Non rep	Do not repeat	Ut dictum	ut dict	As directed

Many facilities use a “claim check” system to provide for identification of prescriptions and refills. The CHCS also has a feature that allows clinics to print a “snapshot” of the prescriptions the provider has entered into the computer for a patient. If your facility uses this feature, you can verify exactly how many prescriptions the patient should receive.

Reading, interpreting, and evaluating the prescription

When you receive a prescription or prescriptions from a patient, immediately make a brief examination of each prescription to determine the legibility of the patient’s name and the time required for compounding or filling. Handwriting is often hard to read. In case of illegibility, tactfully ask the patient for the correct spelling. For example, “Is the first name Jon, John, or Joan?” A correctly spelled name on the finished label is psychologically important to the patient.

If the time required for compounding/filling isn’t too long, nothing need be said. However, the patient will appreciate being advised of a lengthy waiting period and may prefer to return after the estimated time of completion.

In order to prevent fears or doubts on the part of the patient, make a careful examination of the prescription behind the counter. If necessary, this will give you an opportunity to consult with other technicians, pharmacists, or prescribers regarding the prescription.

Constantly apply the knowledge you’ve gained from academic training and experience to determine the safety and efficiency of any prescription. The ingredients, quantities, directions, and other parts of the prescription, when considered together, must indicate effective therapy.

Read and completely understand each prescription before you attempt to compound or fill the medication requested. Keep in mind, each word, abbreviation, or mark has a meaning. To assume an illegible or confusing word is an invitation to making mistakes. *Never dispense guesswork.*

Translate abbreviations with caution. Many abbreviations are derived from Latin terms. Some terms are shorthand for common terms and become accepted locally. Therefore, learn to correctly interpret all abbreviations in accordance with the intent of the prescriber.

Legibility is a problem requiring alertness and critical judgment on your part. Careless handwriting and similarity in spelling of names of different drugs add to the difficulty. Although you can usually adjust to the writing peculiarities of regular prescribers, as the number of new drugs increases, the danger of mistakes due to similar names and the importance of care and double-checking increases.

Provider writing isn’t the only handwriting found on prescriptions. Sometimes, while you’re reading and evaluating a prescription, changes must be made. For example, let’s say a prescription is written for Erythromycin 500mg #30, dosed at 1 tablet, three times daily, for 10 days. You find your pharmacy only has 250mg tablets. In this case, the prescription must be changed and the change must be properly annotated. Local policies may prevail, but normally, all changes are made in red ink. Red stands out in what sometimes can look like a sea of scribble. To prevent confusion, circle what’s to be changed. In our example, the 500mg, 1 tablet, and #30 would be circled. Again, this circling brings attention to what has been changed. Never totally cross out an entry, even if you make a mistake; instead, line through and initial it. This gives anyone who may happen to see the prescription a better idea of what went on. Write in your change legibly and initial by it. In our example, you’d write in 250mg, 2 tablets, and #60. Your change is now part of the prescription and will be treated as such throughout the rest of the process.

Provider order entry (POE)

Everything you’ve learned so far has dealt with paper prescriptions. The earlier mentioned CHCS gives you another means to process prescriptions. This is the POE. In this method, the prescribers open computer terminals are just like having a signed, blank prescription pad on their desk. With POE, the prescribers input prescriptions by simply choosing the patient, inputting a medication,

directions, quantity, and refills. The prescription is sent to the pharmacy in a batch. There are three important concepts in POE:

1. Batching.
2. Edits.
3. Clinical screening.

Batching

You know about batching from your experience with CHCS. All information is placed into a batch for processing just to keep some order to the system. Your local system may be set up for periodic batching to a specific printer for POE, or you may be on a manual batch. If there are any POE labels waiting in queue when you're done inputting your paper prescriptions and batch printing the labels, they'll also print.

Edits

With POE you don't have to worry about a prescriber's awful handwriting. That's the good news—the bad news is that providers sometimes don't pay attention to what they're typing. In pharmacy, we're pretty particular about reminding patients that certain medications are oral (PO), or that they can *CHEW* some types of tablets. Keep in mind, some seeming simple words can often confuse patients. For example, calling a docusate sodium capsule a tablet can confuse some patients. Providers don't always catch those kinds of things, so you'll have to edit the prescription for them. Edit POE prescriptions in the same manner you would other prescriptions.

In POE, the only function that isn't available to the pharmacy is canceling a prescription. If a prescriber inputs medication for the wrong patient, you can't fix it by simply merging the prescription over to the correct patient.

Clinical screening

Within the CHCS, there are parameters that are set up to look at every medication in a patient's profile. When a new medication is added to the profile, the CHCS looks for duplicate medication and interactions. If a problem (clinical screening) is found, the CHCS won't allow you to continue the prescription process until questions are answered to "clear" the screening. Problems may vary from the fact this patient just picked up a refill from an earlier prescription for the same medication 5 days ago, to a patient taking an H-2 blocker along with an antibiotic and the H-2 blocker will interfere with the absorption of the antibiotic.

When a clinical screen warning appears on your screen, don't ignore it. Each facility will have very specific guidelines on what to do. Follow those guidelines. If you're not sure what to do, call a supervisor or pharmacist over to review the screen warning.

Verifying patient eligibility

Establish the eligibility of every patient by checking the patient's identification card. The CHCS will automatically and transparently verify Defense Eligibility Enrollment System (DEERS) enrollment. If the patient is eligible, no confirmation will be received. However, if a patient is ineligible, a statement to that effect will be received. If a patient (especially one presenting prescriptions from a civilian prescriber) is found to be ineligible after receiving treatment or medication, his or her personal information and information regarding the medication/treatment received will be forwarded to the resource management office for collection action.

There are many DOD programs that extend eligibility to separating members and their families. You may see ID cards stamped with the initials TA, or temporary cards. Get familiar with the programs your facility supports. Don't forget, we're custodians of the most expensive benefit the military provides. Never hesitate to question eligibility, just as long as you do it professionally.

Labeling

Although labeling a prescription is one of the final steps in dispensing prescriptions, preparing the label happens nearly first. Through inputting information into the CHCS, all required information for the label is compiled and properly formatted.

The label reminds patients of their providers' instructions every time they take their medication. The label may be the only reminder for patients who take pro res natum (PRN) medications (these are drugs to be given when a clinical need arises). The following information must appear on all outpatient labels:

- Address of medical facility.
- Name of patient.
- Date of filling.
- Name and strength of medication.
- Quantity of medication.
- Name of prescriber.
- Prescription number.
- Initials of typist.
- "Keep Out of Reach of Children."

Although it isn't mandatory, you can always add other specific, important information to the label.

Sometimes, things are taken for granted. For example, a penicillin tablet is taken orally, not chewed; or maybe that albuterol nebulizer solution isn't meant to be taken orally. It never hurts to add "by mouth" or another route of administration to a label. Also, be sure to include an action verb. Again, you may not realize it, but sometimes the action verb, (e.g., take, instill, insert, inject) will help the patient to properly take the medication.

Type all labels neatly. In addition, neatly affix the label to the container in a proper position. Identify small tubes or commercial containers with a prescription number affixed to them and then repackaged in a suitable container.

Always be alert to provide additional information on the label to assist the patient in using or storing the prescription correctly. Label short potency date items with the expiration date and explain to the patient upon dispensing. Affix auxiliary labels to containers as required. Bring these labels to the patient's attention.

Short codes

It would take forever to process a label if you had to type every word in medication name and strength, directions, and worry about getting every letter of each doctor's name correct. Today, pharmacy computer systems make your work much easier with short codes. Short codes become your own sort of shorthand. You'll learn all three types of short codes used in outpatient dispensing:

1. Medication.
2. Sig.
3. Provider.

Medication short codes

These refer to the abbreviated text you input into the CHCS to select which medication to dispense. By this time in your training, you've probably been exposed to many of the medication short codes used in your facility. The standard code for inputting medications for the CHCS is the first three letters of the medication name followed by its strength. For example, acetaminophen 325 mg, would be input into the medication field as "ace325" or "tyl325" for its brand name Tylenol®. When

duplicates occur, or when even shorter names will help speed up the prescription process, your pharmacy staff can develop additional codes for combination medications. For example:

- ACT may be used for the combination medication Actifed®.
- PROV10 may be used to distinguish between Provera® 10mg and Procardia® 10mg.
- T3 may be used for Tylenol® #3.

The CHCS allows numerous codes for each medication; however, the standard code should always be available. This standardization serves as a constant when you move from pharmacy to pharmacy.

Sig codes

Another system that stays constant from pharmacy to pharmacy is the sig code database. When the CHCS was developed, sig codes were developed. Under the previous Tri-service Microcomputer Pharmacy System (TMPS), each pharmacy could have their own unique sig code system. For example, at one pharmacy “TT” could mean, “Take two tablets,” while at another, “TT” could stand for “Take two teaspoonfuls.”

When a person moved from one pharmacy to another, it often takes months to learn all of the codes. Thankfully, the CHCS has standardized all sig codes and made it impossible for pharmacies to change, add, or delete from the list. This continuity and standardization means that once you learn the sig codes, you don’t have to worry about them changing!

Provider short codes

Provider codes are the last of the short codes. They’re used when you’re entering the provider’s name for the prescription label. There’s also a standard for this code. The first five letters of the provider’s last name and his or her first initial are used to make up the code. For example, if I were a provider, my short code would be “pearsd” (Don PEARSon). If there happened to be a provider in the same system named David Pearse, his code would be “pearsda” (DAvid PEARSe).

The pharmacy staff does have the ability to edit provider short codes; thus, be very careful if you’re told to edit a provider short code. As with many other parts of the CHCS, this is a shared system. What you do to the database affects other sections outside of the pharmacy.

002. Characteristics of dispensing operations

Filling the prescription

Okay, let’s say you have the label typed, the Baker cell is spinning, and you have the prescription in hand. Now what do you do? Actually, there’s not much to be said about filling a prescription; however, we do need to touch on a couple of important items you need to know:

1. Packaging guidelines.
2. Selecting, filling, and labeling containers.

Packaging guidelines

In the A course, you read about the Poison Prevention Packaging Act of 1970 (PPPA) This lesson will provide a little review of that material. AFI 44-102, *Community Health Management*, instructs pharmacy personnel to follow the provisions of the PPPA whenever prescriptions are filled or refilled. All medications, except those exempted by the PPPA, must be packaged in child-resistant packaging. Sublingual dosage forms of nitroglycerin, erythromycin ethylsuccinate suspension, and cholestyramine powder are a few examples of exempted medications.

NOTE: A complete list of exempted medications can be found in the *Pharmacy Law Digest*.

Selecting, filling, and labeling containers

Since most every pharmacy uses plastic prescription vials, a new vial is used each time a prescription is filled. When you’re selecting a vial to dispense, choose one that’s the smallest practical for the

medication and quantity. For example, you wouldn't put 90 hydrochlorothiazide 25mg tablets into a 60-dram vial. Occasionally, a long label will require you to choose a larger vial than you'd normally (those darn prednisone tapering directions go on forever) choose.

Don't go overboard the other way either. You can't fit 30 cephalexin capsules into a 6-dram vial; well, maybe you can, but when the patient opens the vial there will be 25 intact capsules and a lot of dust.

Use the same common sense that's used to fill a prescription container when the label is applied. Think about this: a month from now, when the patient has forgotten his or her visit to the medical treatment facility (MTF) but is still taking the medication you dispensed. What will the patient see? Will it be a label that was applied crooked and hanging over the bottom edge of the vial? Or, will your patient see a "pharmaceutically elegant" label. It may be worn, but it's straight and neat? Take your time. If a double label is required, make sure you aren't covering up any important or required information. Many pharmacies are now using prescription tape to cover and protect the label.

Checking the prescription

After a prescription has been prepared and labeled, it must be carefully checked before it's allowed to be dispensed. This is called re-evaluating the prescription. Now, you' look closely at this process.

Re-evaluating the prescription

A good system of checking is necessary to ensure the accuracy, quality, and safety of the prescription. Whenever possible, have the prescription you're filling checked by someone other than yourself. If you're checking the prescription, first examine the written prescription for legibility, safety, legality, etc. When checking, constantly apply the knowledge you gained from academic training and experience to determine the safety and efficiency of the prescription. The ingredients, quantities, directions, and other parts of the prescription, when considered together, must indicate effective therapy.

Read each prescription should be read until you understand completely before attempting to compound it or fill the medication requested. Each word, abbreviation, or mark has a meaning. To assume an illegible or confusing word is an invitation to making mistakes. *Never dispense guesswork.*

Develop a system. Before you're allowed to check prescriptions, you'll be trained and evaluated. You'll be given a chance to check with supervision and to watch others check. During this time, strive to glean information and techniques. Compile mental lists of how checking will work best for you. Check each prescription in the same manner. Be meticulous. You're the last line of defense between the patient and a medication error. Double-check all the parts of the prescription for correctness. The five parts to double check are as follows:

1. Patient information.
2. Medication.
3. Directions.
4. Dosage.
5. Provider information.

Double-check the patient information

Is the full name correct? Does the patient go by a nickname, or commonly use his or her middle name? If the prescription and label don't match, question it! Is the patient's address and telephone number on prescriptions for controlled medication?

Double-check the medication

Did the typist put in the short code "pro10" and select Prozac 10 mg instead of Provera 10mg? Visually examine the medication. Does it match the prescription? Do you even recognize it? If you

can't identify the medication, check the bulk container or cell. After time, you'll be able to recognize tablets and capsules by shape and color. You'll also know liquids by their smell—really! Run your nose over an open bottle of albuterol syrup, then try the same with cyproheptadine.

Double-check the directions

By now, you've seen some pretty horrendous handwriting. Legibility is a problem requiring alertness and critical judgment on your part. Careless handwriting and similarity in spelling of names of different drugs add to the difficulty. Although you adjust to the writing peculiarities of regular prescribers, as the number of new drugs increases, the danger of mistakes due to similar names, and the importance of care and double-checking increases. Look at the translation of the Latin abbreviations. Did the typist miss the "i" in "qid"? Also, don't forget to look at the refill column. Patients will quickly point out to you that they were supposed to have received refills on their prescription.

Double-check the dosage

First, does the dosage match the prescription? Next, is the dosage prescribed within the accepted therapeutic range? For example, the listed normal dosage for prednisone is up to 80 mg per day. Was the prescription written for 80 mg per dose and multiple daily doses? If it was, raise the red flag! If something just doesn't look right, question it. When you're the checker, you can't be afraid to ask questions.

Double-check the provider information

Remember "pearsd?" Should it have been "pearsda" instead? Again, the label is the only thing the patient has to remember you by. If the prescriber's name is wrong, it looks bad, and it may serve to confuse the patient. An incorrect prescriber name may also serve to confuse the pharmacy. If you have to make a call for clarification and use the label, that prescriber will have no idea what or whom you're talking about. It may be a small item, but it's important that it's correct.

Dispensing the finished product

Ahh, the "out window," what a beautiful place. Dozens of wonderful patients doing exactly as they should, being patient and polite. Okay, I'll wake up now. We all know there's nothing like a waiting room full of angry patients. They've already been stuck, poked, and pinched. They just want to get their pills and go home. Oh, and they want their pills, NOW! However, before you dispense NOW, make two more checks:

1. Re-evaluating the label.
2. Dispense to the right person.

Re-evaluating the label

Whether or not the patient was in the waiting room when you called his or her name, re-evaluate the label when you hand the patient his or her medication. As you pick up the vial, check it out. Is the label straight, are the directions clear to you, do you notice any obvious typographical errors? It doesn't hurt to even peek into the vial and visually check the medication. This just gives you one final chance to make sure you're dispensing an elegantly packaged, correct prescription. Should you be the only person on duty, a greater degree of alertness is required to avoid mistakes. But are you sure that after all is done you gave it to the right person?

Dispense to the right person

When you're dispensing the prescription, say the patient's name clearly and correctly in order to promote a positive relationship between patient and hospital. Remember, some people offend easily; your correctly pronouncing names can reduce chances of friction.

When the prescription is dispensed to the patient or family member, make sure of whom the prescription is intended. A mom or dad may have had 2 or 3 appointments for different children on

the same day, with refills for their other kids. Be positive of whom you're giving prescription medication.

Refills

The prescriber may authorize the pharmacy to refill certain prescriptions by showing this authorization on the original prescription; however, there are specific limitations:

1. Prescriptions CANNOT be refilled for drugs listed in schedule II.
2. Prescriptions for drugs listed in schedules III, IV, and V can't be refilled more than 6 months after the date of issue, nor more than 5 times.

Prescription refills are honored only at the pharmacy where the original prescription is on file. In an emergency, or where an agreement exists with a nearby MTF, the pharmacist may approve the transfer of an original prescription by telephone. In this case, the prescription label must show the name and address of the pharmacy where the refill was dispensed. The prescription may be considered "on file" when the pharmacy shares a computer prescription record database with the other facility.

If the system can provide on-line retrieval of the original prescription order, an automated data processing (computer) system may be used to record refill transactions for controlled substances. In the event the system experiences downtime, the pharmacy must have alternate procedures to document the refills of controlled substances.

Because safety closures on plastic containers lose their child-resistant properties with continued use, these containers cannot be reused; thus, both the container and cap must be replaced each time the prescription is refilled. If a glass container has been dispensed, it's necessary to replace only the appropriate closure—provided the label is clean and legible and the container is in satisfactory condition.

Other nonroutine ways medications are dispensed to outpatients

There are two other nonroutine ways medications are dispensed to outpatients. One involves mailing and the other doesn't even require a prescription.

Mailing prescriptions

Routine mailing of prescriptions to any beneficiary isn't authorized; however, a prescription may be mailed to a patient in an emergency or when warranted by conditions of personal hardship. In accordance with postal regulations, packing for prescription medications must be secure so no powder can escape from the package and cause damage to other mail. No markings of any kind that would indicate the nature of the contents are placed on the outside wrapper or container of any parcel containing controlled substances. Above all, patients should be encouraged to enroll in and use the national mail order pharmacy (NMOP) program.

Over the counter (OTC) medications

At the discretion of the MTF commander, a limited number of OTC drugs may be dispensed from the pharmacy at the request of an eligible patient. This policy is designed to reduce excessive use of diagnostic and prescriber resources in treating minor conditions where the patient prefers self-treatment. When authorized by the hospital commander, the pharmacy and therapeutics committee develops a list of medications, including quantities, for the commander's approval.

Counseling the patient

All of the work is done. You've worked the prescription all of the way through the line and it looks good. You called out the patient's name without butchering it. The patient has the bottle in hand. Your work is done, right? No way! What you do next can make or break the whole pharmacy experience.

History

Pharmacies have been providing medication information to patients for as long as the practice of pharmacy has existed. The quality and organization of the information provided, though, have varied significantly. Since the Omnibus Budget Reconciliation Act of 1990 (OBRA90) went into effect on January 1, 1993, pharmacies have struggled with how to implement the section of this law that deals with pharmacy operations.

Different approaches

Your speaking ability, attitude, and people skills play a huge part in what approach you'll take in counseling patients. The first thing to remember is, never dispense a medication to a patient without some understanding of why the patient is taking the medication and what it will do to the patient. The type of medication will also play a big part in how you approach your counseling situations. The following are some basic concepts that will help you become an effective counselor:

- Know your audience.
- Be sensitive.
- Know what questions to ask.
- Lay the groundwork.
- Ask open-ended questions.
- Offer follow-up.

Know your audience

Your counseling technique must be specific for the age of the person for whom the medication is prescribed. As our bodies mature, medications will effect us differently. Be aware of the patient's age. Counseling is important for all ages; however, be more concerned with medications for the very young and the very old.

Parents picking up medications for their young, sick child may be distraught over the illness. Their mind isn't focused on listening to you; instead, they just want their child to feel better. Overdosing could be more of a problem here since sometimes the parent rationalizes "if one-half teaspoon is good, one whole teaspoon will be better." Another important note is the route of administration. If a baby has an ear infection, wouldn't it make sense to put the antibiotic suspension in the baby's ear? I have seen more than one little child with amoxicillin suspension running out of their ear.

Elderly patients account for 12 percent of the American population; however, they use 30 percent of all prescribed medications and 40 percent of all OTC drugs. Studies show that ambulatory elderly patients take an average of 7.9 drugs per person each day. The elderly present your greatest challenge! Memory deficit, attempts to speed recovery, side effects, interactions, visual impairment, and just a general misunderstanding of the directions can cause noncompliance or over/under usage of drugs by this group. A few extra seconds of attention in explaining directions or offering nonchild-proof caps can make the difference between proper or incorrect dosing.

Be sensitive

Remember, your patients are tired and have been through a lot. Empathize with them. Pay attention to what the medication is and what it's to be used for. If your counseling area is only semiprivate, you'll want to watch how loudly you discuss sensitive medications with a patient.

Know what questions to ask

Determining the purpose of a patient's prescription may be a tricky procedure. One medication may have numerous approved indications. The same medication may also have many indications that aren't listed as approved. If asked the wrong question or given the wrong information, patients may become angered, mistrust any information given, mistrust their provider, or become afraid they have a disease they aren't aware of. For example, a prescription filled for a tricyclic antidepressant may be

for any number of indications. Let's say a female patient who suffers from headaches is inadvertently informed she is receiving an antidepressant. Upon hearing this, the trust between the patient and provider may be damaged and she definitely won't hear anything else you have to say.

Lay the groundwork

A good place to start with counseling is to find out where you have to go. The question, "Have you used this medication before?" works wonders. A "yes" cuts your work in half.

Ask open-ended questions

If the patient hasn't used a particular medication before, do some detective work. Ask questions such as, "What did your provider tell you about this medication?" This question should give you a good indication of where you need to go. Remember the tricyclic antidepressant? Open-ended questions allow the patient an opportunity to open up and help you.

Offer follow-up

Remind the patient that he or she can call the pharmacy or stop by with any questions he or she has about the prescription. This not only serves to wrap up your counseling, but also leaves a lasting good impression with the patient.

Automated dispensing equipment (ADE)

ADE plays a major role in both inpatient and outpatient dispensing. The equipment makes doing our job so much easier that manning can be adjusted because of its use. Some ADE serves dual purposes, being utilized in both inpatient and outpatient pharmacies, while others are more suited to one or the other.

When found to be empty, automated dispensers will be filled during the day. A form for recording the filler's initials, date filled, manufacturer, lot number, and expiration date of any drug used in an automated dispensing system will be placed on the face of each unit.

The automated dispensing system should be audited weekly to determine if it's counting accurately, and filled correctly. This information is recorded on an automated dispensing system (QA) form. Different forms are used at different bases—check with your supervisor to see which form is being used at your base. Now, look at two pieces of ADE:

1. Baker™ equipment.
2. Pyxis™ equipment.

Baker™ equipment

Baker is probably a familiar name to you. Undoubtedly, your pharmacy has some sort of ADE made by this company. Baker cells and cassettes provide a quick and accurate method to dispense medication. Baker units are normally leased from the Baker Company. The lease agreement includes counting and control units and unlimited replacement of the cells/cassettes. Each cell/cassette is specifically designed for a particular type of tablet or capsule. Grooves cut into the bottom of the cell are fit for the medication, allowing the tablet/capsule to drop past a counting arm into a chute. The cassettes work in a similar manner. The cells and cassettes require periodic maintenance, depending of what medication is dispensed. Some tablets give off quite a bit of dust; therefore, the equipment will require weekly cleaning. Conversely, others may only need cleaning every month or two. The Baker Company has guidelines on how to maintain each part of the system and provides the proper materials when asked. Use only approved materials when cleaning your Baker system or it could mean hours on your hands and knees picking up 10 mg propranolol tabs that spilled out.

Pyxis™ equipment

Pyxis equipment is suited for use in both the outpatient and inpatient settings. The Pyxis console looks like a small chest-of-drawers that can be configured with different size drawers for different

needs. For noncontrolled medication, standard drawers with separators can be used. This option gives you access to all medications in the drawer. For controlled medications, a lid over the drawer allows access to only the selected medication. On the nursing unit, a nurse enters the patient's name into the console, selects the medication, performs an inventory, and removes the medication for administration. Pyxis equipment documents who entered the drawer, what was taken, and even when it was taken. The Pyxis console also provides pharmacy personnel with a report of what was used and what the preset level should be so inventorying and restocking is easy.

On the outpatient side, Pyxis can be used in the emergency room to store prepackaged medications for after-hours dispensing, single doses to be given in the hospital, and controlled medication control. Access is granted in the same method as on a unit and the same usage reports are available.

In the pharmacy, Pyxis can be used to restrict access to controlled medications as a replacement for a "break-out" box.. This requires you to enter patient identification each time a controlled prescription is filled. The inventory report can be compared to CHCS reports to decrease the occurrence of counting errors.

Dispensing restrictions

Restrictions! Do you mean you don't just give everybody anything they want? It's been said that the only way to make every patient happy is to open the pharmacy doors and let people come in and take whatever they want. All joking aside, there are rules (restrictions) you must play by. These include the "closed formulary" system, federal and state regulations, and even local policies.

Formulary and dispensing guidelines

You learned about the formulary in the A course. You know each facility must have a formulary of approved pharmaceuticals. AF formularies are called closed because the pharmacy and therapeutics (P&T) committee must vote on admissions and deletions. If a medication isn't listed on the formulary, it can't be dispensed from your pharmacy. For example, let's say a medication was bought for a Doctor X to dispense on a trial basis is on hand, but not yet approved for formulary addition. In this case, you can't dispense that medication to Doctor Y's patient.

Formularies also restrict you through prescribing guidelines. Prescribing guidelines are the restrictions to treat only certain diseases or indications with a given medication. When tretinoin first came out for acne, doctors found it also helped with photo aging (wrinkles). Many pharmacies added the prescribing guideline restricting the use of tretinoin to acne.

Be careful when you're discussing these restrictions with people outside of the pharmacy. It's illegal to restrict a patient class from a medication—AF pharmacies can't carry anything for active duty only. The words you use to describe formulary restrictions to patients and providers carry a lot of weight.

Investigational drugs

This last section on outpatient dispensing covers a peculiar type of drug called investigational. They derive from the fact that certain AF pharmacies participate with the Food and Drug Administration (FDA) in studies of new drugs. In this lesson segment you'll study the procedures within the Department of Pharmacy for storing and documenting the dispensing of investigational drugs. In addition, procedures have also been established for conducting or monitoring studies involving FDA approved drugs.

Procedural guidance

The AF policy is to encourage and support clinical investigations that contribute to the progress of the biomedical sciences and efficiency of the AF Medical Service. The AF Surgeon General monitors compliance with FDA on the use of investigational drugs and devices.

Investigational drugs or devices

These drugs or devices (implants, pacemakers, etc.) aren't FDA approved for marketing. Investigations may be conducted on drugs or devices not FDA approved, or for the use of FDA approved drugs or devices in a manner not provided in the indications.

The MTF institutional review committee (IRC) and the Surgeon General's IRC must grant permission to practitioners to conduct studies involving investigational drugs. Emergency approval for using an investigational drug must be obtained in accordance with guidelines issued by the MTF Research and Development (RD) personnel. The process of submission and approval of investigational protocols should be described in a MTF clinical investigation guide.

All investigational drugs must be used under the direct supervision of the authorized principal investigator. The pharmacy supports investigational drug studies by storing and monitoring the dispensing of the investigational drug.

Investigational drugs accepted for monitoring by the Department of Pharmacy must be properly labeled and accompanied by a study protocol. Pharmacy personnel are to notify the principal investigator or his or her designee when it becomes necessary to obtain additional study drugs.

If possible, pharmacy personnel should store investigational drugs under lock and key and in areas designated for this purpose. Drug quantities exceeding secured storage space should be labeled or identified "For Investigational Use Only" and stored in an appropriate area.

Using forms provided by the investigator or locally produced forms, pharmacy personnel should document the dispensing of investigational drugs by recording each quantity dispensed. These forms and any remaining investigational drugs should be given to the investigator at the conclusion of the study.

Drug studies

Clinicians must have approval of the MTF IRC before conducting drug studies involving FDA approved drugs in people or animals. All items discussed previously must be followed.

Some protocols are more practically implemented if the clinician investigator dispenses or uses the drug him or herself in accordance with the study protocol. The decision to give the investigator drugs to support his or her protocol, or to dispense drugs in the conduct of the protocol, rests with the Chairman, Department of Pharmacy.

Protocol sheets

Drug study protocols will be maintained in the pharmacy. Appropriate cover letters and documentation of procedures should be provided to the various sections involved in the study.

Drug information

Investigators and/or nursing personnel requesting drug information should be referred to Pharmacy Services if such information isn't documented on the protocol. Drug information should be provided to the wards involved with the administration of investigational drugs.

Dispensing study drugs

Study drugs may be dispensed to outpatients and wards/clinics upon receipt of a prescription or Doctor's Order from the principal investigator or designated co-investigators.

Outpatient prescriptions

Prescriptions for outpatients should either be filed in a special folder established by pharmacy personnel, or the prescription number noted on the monitoring sheet. In either case, the prescription is filed with routine prescriptions.

Inpatient Orders—Doctor's Orders, AF Form 3066

An AF Form 3066 should be sent to the Inpatient Pharmacy to order drugs. The AF Form 3066 should then be attached to an Intravenous Solution Profile Card and any documentation or randomization be performed in accordance with the study's procedure letter.

All running inventory sheets should be annotated with the appropriate information, as per protocol, as doses are used for reconstitution.

All investigational drugs maintained by the pharmacy should be inventoried at least weekly and any discrepancies will be noted and resolved at the time of inventory. All documentation must be retained for at least 2 years. When possible, the computer inventory for investigational drugs will be programmed to print "Investigational Drug" on labels generated for product dispensing.

Additional information on this subject can be found in AFI 40-403, *Clinical Investigation and Human Test Subjects in the Medical Service*, and in the ASHP publication *Pharmacy-Coordinated Investigational Drug Services*.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

001. Receiving and interpreting a prescription

1. What prescription section contains the Rx symbol?
2. What part of the prescription contains the directions to the maker?
3. What two forms are used by authorized prescribers in AF medical facilities?
4. What's the proper procedure for changing a paper prescription?
5. What two items does the CHCS check for in a patient's profile whenever a new medication is entered?
6. What happens when a patient who has received a prescription is found to be ineligible for care?
7. Name the eight mandatory items on a prescription label.
8. Which type of short code can pharmacy personnel change?

002. Characteristics of dispensing operations

1. What types of medications need not be packaged in child-resistant packaging?
2. Describe “pharmaceutically elegant.”
3. How often should the automated dispensing systems in your pharmacy be audited?
4. What’s the importance of having the correct provider information on the prescription label?
5. What class of medications can never be refilled?
6. Under what conditions are prescriptions mailed to patients?
7. How does asking open-ended questions help you when counseling patients?
8. What are prescribing guidelines?

1–2. Inpatient Dispensing

The organizational structure of the AF hospital places certain constraints on the manner in which hospitalized patients receive their drugs. These constraints revolve around such things as personnel available, professional traditions, and department responsibilities. As a rule, physicians prescribe, pharmacists dispense, and, usually, nurses administer medications. In order for this simple relationship to work, many things must take place. The overall drug distribution and utilization process in the hospital involves an infinite number of procedures, personnel, and equipment. In this section you’ll first look at the concept of inpatient dispensing. Then, you’ll learn personnel responsibilities and equipment.

003. Concept and Responsibilities

There are basically two systems in use in AF hospitals to dispense medications to inpatients:

1. Floor-stock.
2. Unit-dose.

Floor-stock

Floor stock is mainly reserved for items that aren’t entirely consumed by one patient (e.g., a pint bottle of alcohol or hydrogen peroxide). This method of stocking inpatient units goes back to “the

good old days,” and consists of standardized bottles of medications from which the nurse can administer doses to patients on the unit. The charge nurse of each unit and clinic prepares a list of routinely used pharmaceuticals and indicates the approximate weekly levels to be stocked. This list is submitted to the pharmacy and, when approved by the P&T committee, constitutes the “authorized list of drugs” to be routinely stocked in each using activity. The pharmacy supplies standardized containers, uniformly labeled, unless the quantity or nature of the drug requires it to be dispensed in the original container.

A label is securely affixed to all inpatient unit stock containers and must indicate the following information:

- Strength.
- Inpatient unit identity.
- Generic name or trade name, or both.
- Name and address of the medical facility.
- Manufacturer and lot number (or coded equivalent).
- Additional information to ensure drug potency and patient safety, as required.

Ordering in bulk quantities

Units, clinics, and other using departments may procure drugs or preparations from the pharmacy by a written request on DD Form 1150, Request for Issue or Turn-In, or through the CHCS. All schedule II drugs, including ethyl alcohol, medicinal whiskey, wine, or brandy, require a separate request. The pharmacy issues AF Form 579, Controlled Substances Register, which is maintained for each drug. Each time the drug is issued to the unit, pharmacy personnel must make the appropriate entry and the nurse must initial for receipt. Completed registers are returned to the pharmacy for accountability and filing.

Patients transferred from other medical facilities may have in their possession medication prescribed by the transferring physician. All medications prescribed for individual patients that are discontinued—as well as medication that’s contaminated, deteriorated, or unidentifiable—are returned to the pharmacy.

The use of a floor-stock-type system will normally involve two containers of each medication listed on the authorized drug list. When one container is empty, it’s sent to the pharmacy to be replenished, leaving the additional container available on the unit for administration.

To minimize these floor-stocks, control contamination, and decrease waste, the use of unit-dose drugs, which permit drug identification up to the point of administration, is recommended for inpatient units.

Unit dose

AFI 44-102 dictates that a unit-dose system will be used to the maximum extent possible. This distribution system was designed in response to the observation that pharmacy personnel are educated and capable of providing more extensive professional services than traditional medication distribution systems allowed.

The basic difference between the unit-dose system and older methods of medication distribution is the more active role of pharmacy personnel in the medication cycle. The medication cycle is the sequence of events that transpires from the writing of a drug order by the physician to the eventual administration of the medication to the patient. The patient gets the benefit of trained pharmacy personnel being responsible for the medication cycle. This also frees up nurses so they can return their attention to patient care responsibilities.

Pharmacy personnel review a copy of the physician-generated medication order. All medication preparation steps are monitored. Pharmacy personnel also maintain patient-specific drug profiles that

detail allergy and organ function. This places pharmacy personnel and the physician in an interactive role, once again, to the benefit of the patient.

The unit-dose distribution system is based on unit-dose packaging; that is, each dose of medication is placed in an individual package having a label listing the drug name, strength or concentration, lot or batch number, and expiration date. This is very different from the bulk containers you learned of, where multiple doses are measured out on the unit or ward for administration to multiple patients.

Unit-dose packaging provides individual containers of single doses of medications (oral solid, oral liquid, respiratory therapy, or injectable) for dispensing. The end result is pharmacy personnel dispensing only the doses each patient needs during a designated period— usually 24 hours. The majority of medications are available in unit-dose packaging from the commercial manufacturer; however, there are still some medications requiring repackaging by pharmacy personnel. This repackaging is accomplished using equipment and procedures that ensure drug integrity and patient safety.

One of the largest impacts unit-dose packaging had is that trained pharmacy technicians (you and I) are now used in preparing medication for administration. As technicians, we also handle other mechanical elements of the medication cycle. Utilizing pharmacy technicians for these very important tasks frees up pharmacists from many manual-dispensing tasks, allowing them to devote more time to other responsibilities. There are two types of unit-dose system designs:

1. Centralized.
2. Decentralized.

Centralized

Most MTFs offer this type of service. Centralized unit-dose services are normally provided from a single, self-contained location in the MTF. The pharmacy receives or picks up copies of all medication orders, and all medications are prepared, packaged, and dispensed using unit-dose methods. This service may include baseline drug monitoring and educational services depending on the staffing of pharmacy personnel.

Centralized service is very useful for small hospitals or those MTFs designed in a manner where a central pharmacy location allows for quick and easy access to all patient care areas. Centralized unit-dose services have an additional advantage of requiring smaller technical and professional staff than required by the more widely dispersed decentralized service.

Decentralized services

Larger MTFs offer this type of service. Decentralized unit-dose distribution systems operate from two or more dispensing locations. These locations normally provide doctor's order review and first dose dispensing. In most large MTFs, it isn't necessary to duplicate all pharmacy activities at the dispensing sites. Usually, there's a central support pharmacy to support the drug distribution functions and concentrate activities that aid large-scale operations in maintaining efficiency. This central support pharmacy normally provides services such as unit-dose cart filling, medication repackaging, IV admixture compounding, and controlled substance distribution. These products are then transferred to the outlying locations, where they're made ready for delivery to the units.

Some MTFs offer specialized pharmacy satellites when a particular service identifies specific clinical needs. Examples would be pediatrics, oncology, critical care, emergency room, and operating room.

Mobile pharmacy cart system

For the most up-to-date decentralized unit-dose service, there's the mobile pharmacy cart system. This mobile cart is transported from one unit or ward to another. This cart is normally operated by a pharmacy technician and offers first-dose service and baseline drug monitoring (usually by a pharmacist) during specific times of day.

Stand-alone cart system

There's also a stand-alone cart system available. This cart system offers a picking-station for nursing personnel when pharmacy personnel aren't available.

Responsibilities

The functions and responsibilities of pharmacists, pharmacy technicians, and nurses have undergone dramatic changes with the development of the unit-dose delivery system. The earlier discussed floor stock system required nursing personnel to perform many medication-related duties. Also, pharmacy personnel had few responsibilities, except for drug compounding, packaging, and labeling. Now, however, many of the medication-related activities once performed by nursing personnel are being assumed by pharmacy personnel. This change allows nursing personnel to be more involved in other direct patient care functions. All in all, the patient is the winner in this tradeoff. The expertise of pharmacy personnel is utilized in medication therapy, and nursing personnel have more time to provide nursing care.

Pharmacy technician responsibilities

Pharmacy technician taskings have grown tremendously because of the unit-dose delivery system. One such tasking is in the area of advanced unit-dose medication packaging and labeling. This task allows for staff other than the pharmacist to perform the majority of manipulative tasks associated with drug preparation and delivery.

The pharmacy technicians' work is supervised and checked by pharmacists or senior pharmacy personnel. This double check is a safety feature that wouldn't be available if one person prepared and immediately administered a dose (which is basically what nursing personnel have been doing for years).

Technicians perform most duties related to medication preparation and delivery. Because pharmacy technicians perform most of the time-consuming tasks, pharmacists and senior pharmacy personnel are free to pursue other opportunities.

Types of medication order systems

The biggest change caused by the unit-dose system is that pharmacy personnel now review a copy of all medication orders written by physicians before medications are dispensed to the patient. This procedure allows for intervention, if necessary, to prevent inappropriate drug prescribing. It also allows pharmacy personnel to influence improved drug therapy *before* medications are administered to the patient.

There are various methods used to review all patient-specific drug orders. Some MTFs may require pharmacy personnel to transcribe the contents of the original physician order to pharmacy records that are used in pharmacy dispensing activities. Other MTFs may use facsimile (FAX) devices to transmit copies of the order from the inpatient unit or ward to the pharmacy. Still other MTFs may have computerized doctor order entry available on the inpatient unit or ward.

AF Form 3066

Most MTFs use AF Form 3066 as their medication order form. Some MTFs have overprinted the AF Form 3066 so the medication orders are written within columns labeled for drug name, dose, route of administration, and interval. These columns help to ensure the physician remembers to identify each of these items when prescribing a medication. Another type of overprint is the type used for routine orders that are needed for patients before surgery, childbirth, or other procedures.

When the prescriber writes a medication order, a copy of the original is simultaneously created because of the multi-copy form. The copy is then sent to/or picked up by pharmacy personnel for review and filling.

Automated medication order entry system

AF pharmacies are now in a transition from the traditional, paper-intensive system to a fully automated medication order entry system. Once complete, this automated system should simplify the order entry process. All prescribers will enter medication orders directly into a computer terminal. The computer will then generate any documents needed by nursing and pharmacy, as well as becoming the permanent medical record. With this system, the need for manually prepared medication order forms will eventually be eliminated. This practice is already in place in some MTFs; however, (you should have known this was coming) until that time, we'll have to continue using the old paper method.

Maintaining medication profiles

Most of the time, medication order processing under the unit-dose system involves quite a few steps. These steps are designed to allow for multiple checks of each dose of medication before it's administered to the patient. Once the prescriber writes an order on the AF Form 3066, two things happen.

First, a copy of the order is sent to the pharmacy. Once it gets to pharmacy personnel, it's entered into the CHCS. Then, a pharmacist or senior pharmacy technician reviews and edits the medication order, comparing each entry to the patient's previous drug orders and the information kept in a patient-specific medication profile. If there's a problem with the order, pharmacy personnel intervene. Normally a call to the prescriber is warranted. This call is made to suggest more appropriate alternatives. A 24-hour supply of the medication is prepared (or enough to last until the next unit-dose exchange). A pharmacist or senior pharmacy technician checks each dose prepared to ensure accuracy. Once the item has been checked, the item is delivered to the unit or ward. Most medications are delivered to a specially designed medication administration cart located on the unit or ward.

Second, and simultaneously, the nurse on the unit transcribes another copy of the order onto the unit or ward's patient specific AF Form 3069, Medication Administration Record (MAR).

The AF Form 3069 is a buddy to the AF Form 3066. It aids in ensuring accuracy and consistency. The order that's transcribed to the AF Form 3069 shows medication doses actually administered to the patient. Before a nurse administers any medication to a patient, the nurse compares the medication label on the drug product to the corresponding MAR entry. Next, the nurse administers the dose to the patient and records the administration of the dose on the MAR.

Discontinued medications are noted by writing "D/C" directly behind the last dose sent to the ward. Preoperative and single-dose medications are entered on the back of AF Form 3069.

Scheduled medication delivery

Scheduled medication delivery is normally done by exchanging med carts. While one day's medications are being administered from the med cart on the unit or ward, another cart (holding or transfer) is in the pharmacy being filled with the next day's supply. Most MTFs fill the transfer cart with scheduled medications that are stable, don't need special storage, and are on a set time schedule, such as every 4 hours, once daily, etc.

On a routine basis (usually once daily), at a predetermined time, the transfer cart is taken to the unit. The bins that held the previous day's doses are returned to the pharmacy, and the replenishment process begins all over again. This is called the cart fill process. Pharmacy technicians normally perform this process. As technicians, we review all previously processed orders and place the ordered amount of each medication into each patient's medication bin on the transfer cart.

Most pharmacies have streamlined the cart fill process. With the use of automated technology and an assembly-line-type approach, this process can be accomplished in a much shorter amount of time than was previously necessary. This increased productivity is achieved by using computerized order entries and printing out computerized reports known as cart lists. The cart list contains patients'

names, all scheduled medications, and number of dosage units necessary for the next 24-hour period. This type of streamlining not only reduces cart fill time, but it actually helps to increase accuracy.

After completion of the cart fill process, each bin's contents are checked to ensure they correspond to the doctor's orders. Most MTFs have a pharmacist or senior pharmacy personnel perform a cart check.

Not all medications are included in the med cart fill process or delivered when the med carts are exchanged. Some examples are PRNs (and other medications not on a regular schedule), unstable drugs, new and statin (stat) orders, air evacuation prescriptions, self-medication prescriptions, emergency medications, and at some MTFs, investigational drugs.

Other medication delivery methods

Some MTFs use a pneumatic tube carrier system to deliver medications to units and wards that are physically distant from the inpatient pharmacy. Still other MTFs have a type of pharmacy courier system for routinely delivering PRN medications and picking up new orders. This courier-type service between the inpatient pharmacy and the unit or ward may operate every 30 to 60 minutes during the day, or less frequently at smaller MTFs. For 24-hour inpatient pharmacies, this process is done less frequently in the evening hours, and still less often at night. Whatever the time interval, all doses are packaged in unit doses and remain designated for specific patients. Now, take a look at five special delivery methods you may encounter on the job:

1. PRN medications.
2. Unstable medications.
3. New and stat medications.
4. Air evacuation prescriptions.
5. Self-administered medication.

PRN medications

These medications aren't usually put in the patients' bins during the cart fill process. They also aren't normally kept in the same bin on the med cart containing the patient's scheduled medication. There are several ways these drugs may be stored and delivered.

For the most part, the most efficient way to distribute PRN medications is the use of a modified floor stock system. A limited floor stock supply of these medications with low toxicity potential (i.e., liquid antacids or laxative agents) can be stored on the med cart so the nurses can easily access them and administer doses to patients when the patients need them. These supplies aren't normally assigned to a particular patient, but they can be supplied in unit-dose packaging. Their rate of use is monitored closely by pharmacy personnel. Pharmacy, nursing, and (most importantly) the patient benefit from this slightly altered concept of unit-dose distribution.

Delivery of PRN medications may be accomplished through a daily replenishing of the PRN medications for each patient; however, this is very inefficient because doses may be repeatedly returned to the pharmacy unused and resent out again the next day.

Another method of delivery is prompted by some type of written communication form (i.e., a locally produced order form or DD Form 1150) used by nursing personnel. The nursing personnel may also use this form to notify pharmacy personnel about missing doses, such as a scheduled medication that isn't in a patient's bin. Two disadvantages are found with this delivery system. It's time-consuming for both nursing and pharmacy and it also can cause delays in the administration of drugs to patients.

Unstable medications

Unstable drugs may be delivered in the manner described previously. Or, in the case of an unstable, scheduled medication, these drugs may be delivered at a predetermined time prior to administration. An example would be a drug with a short expiration time. This could be delivered 1 hour prior to the

scheduled administration time. On the flip side, drugs requiring refrigeration can be delivered at the same time as the med cart exchange and placed in the refrigerator instead of the med cart.

New and stat medications

The delivery of this type of medication is prompted by the new medication order itself. Normally, the medications will require filling prior to the next med cart exchange. In addition, enough doses need to be sent (for new medication orders) to supply the patient through the next cart exchange.

Air evacuation prescriptions

Air evacuation prescriptions are normally filled and processed as outpatient prescriptions. These prescriptions are filled with a 3-day (72-hour) supply of medication. The prescriber must sign air evacuation prescriptions, a nurse's signature won't work. Most pharmacies also print "Air-Evacuation Medication" somewhere on the medication label. Once again, this will vary from pharmacy to pharmacy. Check with your supervisor for local procedures.

Self-administered medication

The intent of self-administered medication is to allow for such medications as antacids, vitamins, etc., to be available at the patient's bedside if the provider so desires. When inpatients are authorized to self-administer medications, the pharmacy staff is responsible for ensuring compliance with the MTFs policies on self-administered medication by inpatients. The following procedures comply with Joint Commission on Accreditation of Healthcare Organizations (JCAHO) requirements and USAF regulations and can be used as a guide.

Medications aren't be self-administered on the ward unless:

- The drug is written on an AF Form 3066.
- The drug isn't a controlled drug.
- The provider must indicate the drug may be self-administered in the patient's medical record.

004. Characteristics of inpatient dispensing equipment

The *United States Pharmacopoeia* defines good manufacturing practices (GMPs) and the requirements that repackaging equipment must meet as follows:

- Equipment used in the manufacture, processing, packaging, or holding of a drug product shall be of appropriate design, adequate size, and location suitable to facilitate operations for its intended use and for cleaning and maintenance.
- Equipment shall be constructed so the surfaces that contact components or drug products shall not be reactive, additive, or absorptive so as to alter the safety, identity, strength, quality, or purity of the drug product beyond the official or other established requirements.
- Any substance required for operation, such as lubricants or coolants, shall not come into contact with components or drug products so as to alter the drug product beyond the official or other established requirements.
- Equipment must be cleaned, maintained, and sanitized at appropriate intervals to prevent malfunctions or contamination's.
- Written procedures shall be established and followed for the cleaning and maintenance of equipment.
- Records shall be kept of maintenance, cleaning, sanitizing, and inspection.
- Automatic, mechanical, or electronic equipment or other types of equipment, including computers, or related systems that will be used in the drug preparation process, must be routinely calibrated, inspected, or checked according to a written program designed to assure proper performance.

The *United States Pharmacopoeia* also defines the requirements that components and drug product containers and closures must meet as follow:

- Components and drug product containers and closures shall at all times be handled and stored in a manner to prevent contamination. Bagged or boxed components of drug product containers, or closures, shall be stored off the floor and suitably spaced to permit cleaning and inspection.
- Drug product containers and closures shall not be reactive, additive, or absorptive so as to alter the safety, identity, strength, quality, or purity of the drug beyond the official or established requirements.
- Container closure systems shall provide adequate protection against foreseeable external factors in storage and use that can cause deterioration or contamination of the drug product.

Repackaging materials

Repackaging materials and the package must meet the following requirements:

- The repackaging materials and the package itself must possess the physical characteristics to protect the drug from external elements such as light, heat, moisture, air, and, in the case of sterile products, microbial contaminants.
- The material mustn't deteriorate during the shelf life of the drug.
- Packages should be lightweight and made of materials that don't interact with the dosage form.
- Packages should be constructed so they don't deteriorate with normal handling. They should be easy to open and use, and their use shouldn't require any additional training or experience.
- Packages should allow for inspection of their contents by the person administering the medication, unless the pharmaceutical properties of the drug prevent its exposure to light.

Types of containers and closures

The *United States Pharmacopoeia* defines containers and closures based on the degree of protection of the contents. They are defined as follows:

Light resistant containers

This type of container protects the drug from the effects of incidental light by virtue of the specific properties of the material of which it's composed. This includes any coating applied to it. If protection from light is required, a clear and colorless or a translucent container may be made light resistant by means of an opaque enclosure.

Well-closed containers

These containers protect the contents from external solids and from loss of the drug under ordinary or customary conditions of handling, shipment, storage, and distribution.

Tight containers

Tight containers protect their contents from contamination by external liquids, solids, or vapors. They also protect from loss of the drug, and from effervescence, deliquescence, or evaporation under ordinary or customary conditions of handling, shipment, storage, and distribution.

Hermetic containers

These containers are impervious to air or any other gas under ordinary or customary conditions of handling, shipment, storage, and distribution.

Oral solids repackaging systems

Oral solids are the most commonly repackaged medications. A greater number of repackaging systems are available for repackaging oral solids than for any of the other dosage forms. The reason for the variety of oral solid repackaging systems is that the majority of doses dispensed in institutions are oral solids, and oral solids don't present the contamination and cleaning problems posed by liquids.

Manually operated oral solid repackaging systems use either a pouch package or a blister package. Each of these two types of packaging can be sealed using heat or adhesive material.

Manual pouch repackaging systems

These systems use a thin mill plastic bag that's made of clear or light-resistant materials. The tablet or capsule is dropped into the bag and the bag opening is sealed with an adhesive. Manual pouch systems can also use a heat sealer (in the form of a hot knife blade) to seal the end of the plastic bag—this provides a better seal.

Manual blister repackaging systems

This system uses a plastic blister package. The blisters or bubbles come in various sizes, depending on the type (tablet or capsule) or size (large or small) of the product being repackaged. The blisters can be filled on a tabletop or placed in specially designed holders to cradle the package. Once filled with the drug, a backing made of paper, foil/paper, or vinyl/foil/paper is attached to the blister by removing a protective covering on the adhesive strip and applying pressure to the blister and the backing material.

Heat-sealed blister packages use a similar system; however, the backing and blister are heated in what best can be described as a waffle-making iron. The heat seal press places heat and pressure on the backing material, while the blisters remain protected by the well-like device they sit in.

Automated oral solid repackaging systems

Automated oral solid repackaging systems have been available for the past 30 years. Today's machines represent the latest technological advancements in computerized labeling, hot stamp printing, and mechanical simplicity.

Unit-dose strip packaging machines

Automated oral solid repackaging systems are commonly known as strip packaging machines, and they operate in basically the same fashion as the manually operated machines. They all produce a pouch package made up of two laminates. Tablets or capsules are manually fed into a wheel that drops the dose into a pouch that's formed by two heated wheels, and the product is sealed. Individual packages are separated by a serrated knife blade, which perforates the strip of pouches as they pass out of the machine. The polyethylene/foil/paper is imprinted with the required information by means of a stencil/ink system (wet or hot stamp) or a computer-generated printing system that's tied into the packaging machine. The printing process occurs before the dose is dropped into the pouch.

Automated repackaging machines can package from 60 to 120 doses of a single drug per minute. A device can be attached to the top of the automated strip-packaging machine to eliminate the need for an operator to feed tablets and capsules into the wheel.

Oral liquid repackaging systems

Oral liquid repackaging systems can be divided into three categories:

1. Manual.
2. Semiautomated
3. Fully automated.

NOTE: Some semiautomated systems are basically manual systems that have some automated fluid delivery system associated with the filling process.

Manual repackaging systems

Manual repackaging systems for oral liquids use a glass or plastic vials as the reservoir for the liquid medication or a glass or plastic syringe. Manual repackaging systems requiring vials have these three different closure systems:

1. Screw cap vials.
2. Vials having permanently affixed tops and small fill holes for medication.
3. Vials requiring the addition of a cap that must be crimped.

You can use syringes, burettes, pipettes, or graduates to measure and administer the liquid into the vial.

Manual systems for oral liquids that have syringes as their final container have two methods of repackaging.

1. The first method relies on the operator transferring the liquid to a suitable vessel (such as a beaker) and withdrawing the liquid into the syringe. An ordinary syringe can be used for this process if the number of dosage units is relatively small.
2. Many pharmacies choose to use a Cornwall syringe (often referred to as a magic syringe) to speed the filling process. The Cornwall syringe is preset with the appropriate volume to dispense.

Semiautomated systems

These are manual systems that use some piece of automated equipment as part of the filling or sealing process. Semiautomated systems generally offer greater consistency and reliability in the final product by ensuring an accurate fill volume and, in some cases, a better closure seal (in the case of crimped vials).

Like manual systems, semiautomated systems can be grouped into systems that use a vial as the drug reservoir and those that use a syringe as the final container. Because the semiautomated filling machines (pumps) can be used with either container, we'll consider the difference in these systems based on the type of pump used. Pumps can be subdivided into syringe pumps and peristaltic pumps.

Syringe pumps

These pumps get their name not from filling syringes but from using a syringe as a measuring and filling chamber prior to expelling the liquid into the final container (either a syringe or a vial). Syringe pumps operate on the same principle as do Cornwall syringes. However, syringe pumps use a mechanical process for drawing back and pushing forward on the plunger. The volume to be dispensed into the container is preset based on the drawback setting and the type of syringe selected for the machine.

Peristaltic pumps

This pump gets its name from the peristaltic form of pumping action they employ in delivering fluid. These peristaltic action is created by a series of roller wheels being pulled across a length of tubing. As each wheel passes over the tubing, the tubing is crimped and a small volume of fluid is forced along its pathway down the tubing. Peristaltic pumps offer two advantages over syringe pumps:

1. A faster rate of delivery for larger volumes (10 ml and above).
2. The ability to deliver fairly viscous liquids.

One of the major problems encountered with peristaltic pumps is calibration. If a large number of units are to be produced, the pump will probably require frequent re-calibration.

NOTE: Syringe pumps don't experience this problem to the same extent as peristaltic pumps. In addition, syringe pumps are more accurate and reliable for delivering fluid volumes of less than 10 ml.

Fully automated system

One fully automated machine uses plastic cups as the fluid reservoir. The sealing system is a polyvinyl/foil/paper overseal. The overseal acts as the label, and the labeling is directly printed on the seal as the machine fills and seals the product in much the same way as the automated oral solid packaging machines.

The other fully automated system employs a peristaltic pump that pumps liquid from a fluid reservoir into each cup as the cups pass by the filling orifice. A predetermined amount of fluid is dispensed into each container. The overseal is attached using heat and pressure until a strong bond is made between the cup and the polyvinyl/foil/paper seal. The individual finished packages are separated when the machine cuts the overseal paper between cups.

Both types are equipped with a variety of sensors that detect and signal problems associated with the fill cups, sealing foil, printing tape, and general machine failures. In addition, these machines are capable of producing 20 to 32 units per minute. Their application is packaging liquids with volumes of 15 ml, 30 ml, or 45 ml.

Repackaging injectables

At present, there isn't a fully automated system for repackaging injectable medications; consequently, injectable medications must be packaged manually or with a semiautomated process similar to the processes used to repackage oral liquid medications.

Manual system

The manual system currently used for filling injectable medications into syringes uses a sterile Cornwall-like syringe in a metal pipetting holder equipped with an automatic double valve to form the basis of this pressure-fill system. Drugs from ampules or vials are individually filtered and pooled under aseptic conditions in sterile, empty evacuated containers. The container storing the injection to be packaged is connected to the inlet port of the automatic valve by sterile tubing. A sterile disposable stopcock is affixed to the male Luer port of the automatic valve to convert it (at right angles) to the necessary female Luer filling port. The filling syringe is calibrated to the desired deliver volume, plus any additional volume that may be necessary to overfill the administration syringe (repackaged product). Sterile disposable syringes are placed on the stopcock port and filled. The filled syringe is then removed from the filling port, and a sterile disposable tip is affixed to the hub.

Semiautomated system

The semiautomated system uses a similar approach to the manual system. The only difference is that pumps are used in place of the Cornwall syringe. This is very similar to the progression seen in oral liquid repackaging. In fact, the same pumps used to repackage oral liquid medications are used to repackage injectables. The only difference is in the type of tubing used with the pump. Injectable drugs require sterile tubing, whereas oral liquid repackaging uses nonsterile tubing.

NOTE: Sterile product repackaging necessitates the use of laminar airflow hoods, which meet or exceed these same standards listed previously in the A course.

Unit-dose medication administration cart

As mentioned earlier, medications that have been dispensed from the pharmacy and delivered to the unit or ward are normally stored (securely) on a unit-dose medication administration cart (or med cart).

This is a very unique piece of equipment developed especially for unit-dose drug distribution. These lockable carts usually contain a series of patient-labeled bins arranged in room and bed sequence. Each bin holds a 24-hour supply of medication for the designated patient. Some of these carts may

have storage space for auxiliary supplies. There's normally a flat surface area, serving as workspace and wheels or casters that allow the cart to be moved from patient to patient.

Maintenance of equipment

Most equipment used in the repackaging process requires some form of maintenance. Maintenance can be part of the daily operation of the equipment, or it can be a scheduled maintenance. Unfortunately, most pharmacies don't perform regularly scheduled maintenance on their equipment. And sad to say, some don't even perform preventive maintenance.

The proper maintenance of equipment is important from these two perspectives:

1. Regularly scheduled preventive maintenance can extend the life of equipment. The extension of the equipment's life expectancy can lead to decreased expense in the repackaging operation.
2. Preventive maintenance will translate into less frequent downtimes resulting from equipment failure. Maintenance of equipment will also ensure it's operating to the specifications of the manufacturer and the quality of the package is as good today as when the equipment was first purchased.

Quality Assurance in the unit-dose delivery system

The inception of unit-dose distribution system has led to the development of quality assurance standards to ensure the products and services provided are the best possible. In essence, quality assurance is the tool a pharmacy uses to police its own operation. The goal of quality assurance is to enhance patient care. To make this possible, all activities associated with medication preparation and distribution should be routinely monitored according to predetermined criteria. This monitoring will help guarantee all assigned standards of performance are met.

Quality assurance techniques are used to evaluate the performance of several distribution activities, including the following:

- Filling and checking unit-dose medication carts.
- Creating and updating patient medication profiles.
- Prepackaging unit-dose medications.
- Compounding parenteral admixtures.
- Reviewing medication administration records.

The routine monitoring of these activities will help identify existing or potential problems in the medication distribution process. The monitoring will also allow for a determination of what course of action is required to correct problems.

No doubt, medication delivery systems will continue to evolve during the coming years to meet new challenges of the pharmacy department. To meet these challenges, pharmacy personnel will have to learn to change. As time passes, there will be changes in personnel roles, shifting of resources, expansion of technology, and new clinical services. All along the way, you and other pharmacy personnel will be integrating all these changes into one package that will provide superior patient care.

Buying pharmaceuticals in unit-dose packaging, placing them in the med cart, and delivering them to units and wards won't be enough. We can't leave the practice of pharmacy personnel in the hands of nursing services; instead, our leaders must realize that the ever-increasing complexity of drug therapy will require pharmacy personnel to play a larger part in patient care. If this practice is accepted, therapeutic mistakes will be avoided and prescribed medication therapies will truly improve the patient's quality of life. As pharmacists, our biggest challenge is to prove we can positively impact medication therapy and enhance the quality of medical care.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

003. Concept and responsibilities

1. What are the two methods used in AF hospitals to dispense medications to hospitalized patients?
2. What information is required on all bottles of floor stock medication?
3. Why is the unit dose system recommended for inpatient units?
4. Describe the unit dose system of medication distribution.
5. How does the patient benefit from the unit dose distribution system?
6. Describe the process of maintaining medication profiles?
7. What information is contained on a cart list?
8. Describe the use of the *self-administered* medication system.

004. Characteristics of inpatient dispensing equipment

1. What requirement does the *United States Pharmacopeia* place on any automated, mechanical, or electronic equipment used in drug preparation?
2. List the four types of containers/closures and describe each one.
3. What are the two types of manual tablet/capsule repackaging systems?
4. What's the difference between manual and semiautomatic injectable repackaging equipment?

5. What's the importance of preventative maintenance of repackaging equipment?
6. What tool does the pharmacy use to police it's own operation in unit dose dispensing?

Answers to Self-Test Questions

001

1. Superscription.
2. Subscription.
3. AF Form 781, Multiple Item Prescription, and DD Form 1289, DOD Prescription.
4. Make all changes using red ink, circle the information that's to be changed, and write your initials by your change.
5. Duplicate medications and interactions.
6. The patient's personal information is forwarded to the Resource Management Office for collection action.
7. (1) The address of the MTF, (2) the patient's name, the date the prescription was filled, (3) medication name and strength, (4) the quantity of medication dispensed, (5) the prescriber's name, (6) the prescription number, (7) the typist's initials, and (8) the statement "Keep out of reach of children."
8. Medication short codes.

002

1. Sublingual forms of nitroglycerin, erythromycin ethylsuccinate suspension, cholestyramine powder and any other medication exempted from the PPPA.
2. A properly packaged prescription with a neat, straight label.
3. Weekly
4. It becomes the patient's perception of a quality product, lack of the proper information can lead to patient and/or pharmacy confusion.
5. Class II.
6. Under emergency conditions or when warranted by conditions of personal hardship.
7. It allows the patient to help you in counseling by providing you with pertinent information.
8. The restriction of medications to be used only in certain indications.

003

1. Floor stock and unit dose.
2. Medication strength, unit, generic and/or trade name, name and address of MTF, manufacturer lot number, and any and all information to ensure potency and safety.
3. To minimize floor stock, control contamination, decrease waste, and aid in the identification of medications.
4. Each dose of medication is placed in a individual package. Patient profiles are monitored and a 24-hour supply of unit-dosed medications is delivered to the unit in a compartment labeled for each specific patient.
5. More pharmacy involvement allows nursing personnel to be more involved in direct patient care.
6. Medication orders are sent to the pharmacy, pharmacy personnel input medication information into the CHCS, orders are reviewed and providers contacted to clarify (if needed), a 24-hour supply of medication is delivered to the unit.
7. Patient name, all medications scheduled, and number of doses required for the next 24-hour period.
8. Only noncontrolled, provider-ordered medications, such as antacids and vitamins, to be kept at the patient's bedside and taken daily.

004

1. Automatic, mechanical, or electronic equipment or other types of equipment, including computers or related systems, that will be used in the drug preparation process must be routinely calibrated, inspected, or checked according to a written program designed to assure proper performance.
3.
 - (1) Light resistant, to protect medications from the affects of incidental light.
 - (2) Well-closed, to protect the contents from external solids and from loss under normal handling.
 - (3) Tight, to protect the contents from external solids, liquids, or vapors and from effervescence, deliquescence, or evaporation under ordinary conditions.
 - (4) Hermetic which is impervious to air or any other gas under ordinary conditions.
3. Manual pouch repackaging and manual blister repackaging.
4. Pumps are used in place of Cornwall syringes.
5. Preventative maintenance extends the life of equipment and provides less frequent downtime resulting from equipment failure.
6. Quality assurance.

Do the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to ECI Form 34, Field Scoring Answer Sheet.

Do not return your answer sheet to ECI.

1. (001) What additional information *must* be on a prescription for children age 12 and under?
 - a. Age.
 - b. Weight.
 - c. Parent name.
 - d. Parent telephone number.
2. (001) What pharmacy abbreviation means “without?”
 - a. \bar{c} .
 - b. \bar{s} .
 - c. pc.
 - d. aa.
3. (002) Responsibility for monitoring compliance with the Food and Drug Administration (FDA) on the use of investigational drugs rests with the
 - a. MTF commander.
 - b. Air Force surgeon general.
 - c. Chief of pharmacy services.
 - d. MAJCOM surgeon general.
4. (002) Which medication is exempted from childproof packaging by the Poison Prevention Packaging Act?
 - a. Simethicone drops.
 - b. Amoxicillin suspension.
 - c. Nitroglycerin sublingual tablets.
 - d. Acetaminophen chewable tablets.
5. (002) Responsibility for authorizing the dispensing of “over-the-counter” medications through the pharmacy rests with the
 - a. MTF commander.
 - b. AF surgeon general.
 - c. Chief of pharmacy services.
 - d. Pharmacy and therapeutics committee.
6. (002) Making your counseling techniques specific for the age of the person is an example of what aspect of patient counseling?
 - a. Being sensitive.
 - b. Offering follow-up.
 - c. Knowing your audience.
 - d. Knowing what questions to ask.
7. (003) What information is *not* required on a unit-dose packaging label?
 - a. Drug name.
 - b. Drug strength.
 - c. Patient name.
 - d. Expiration date.

8. (003) Responsibility for approving a nursing unit's authorized list of drugs rests with the
 - a. Executive committee.
 - b. Chief of Pharmacy Services.
 - c. Director of Medical Logistics.
 - d. Pharmacy and Therapeutics committee.
9. (003) How many hours supply of medication are dispensed with an air evacuation prescription?
 - a. 24.
 - b. 36.
 - c. 48.
 - d. 72.
10. (003) The *intent* of self-administered medications is to
 - a. reduce pharmacy's cart filling time.
 - b. ensure availability of newly ordered medications.
 - c. reduce nursing workload and administrative functions.
 - d. allow for provider approved medications to be available at the patient bedside.
11. (004) Which container is designed to protect its contents *only* from external solids and loss of drug under ordinary conditions of handling, shipment, storage, and distribution?
 - a. Light-resistant.
 - b. Well-closed.
 - c. Hermetic.
 - d. Tight.
12. (004) You *cannot* use a fully-automated system to repackage
 - a. tablets.
 - b. ointments.
 - c. injectables.
 - d. oral liquids.
13. (004) The *primary* purpose of quality assurance monitoring of unit-dose delivery is to identify
 - a. existing or potential problems.
 - b. poorly trained technicians.
 - c. training requirements.
 - d. liability issues.

Unit 2. Medical terms, Abbreviations, and Drug Delivery Systems

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AS in other occupations or professions, members of the Medical Service use unique terms and expressions to communicate with one another. In technical school you were introduced to the “language of medicine.” However, since the terms and expressions were most likely new to you, and working situations were only simulated, you probably didn’t retain everything. Nobody expects you to memorize a medical dictionary. Once you know some of the most commonly used medical and pharmacy terms, and develop an understanding of how these terms are formed, you’ll probably be able to figure out what’s being talking about or written on the patient’s orders by the components of the words used.

In order for you to effectively understand what other members of the pharmacy and health care delivery team are talking about, this unit will help to reinforce what you learned in technical school. In addition, ome new terms have been added as well. In the first section, you’ll study the elements of medical terminology and see how these elements are combined to form medical terms. In the second section, you’ll study some medical terms used to describe pharmacy and commonly used medical abbreviations and symbols.

2–1. Elements of Medical Terminology

We’ve designed this section to help you learn commonly used medical terms. We’ll provide you with an understanding of the basic word components. When put together, these word components form those long, hard-to-pronounce (and spell!) medical terms and expressions you’ll encounter daily.

Combining units, called prefixes, suffixes, and root words, form a great number of the words used in medicine and pharmacy. When used alone, many of these units may already be familiar to you; but, when you see and hear them combined in a long, strange-sounding word, they may sound more like a foreign language. There’s a good reason for this because most medical words are derived from ancient Greek and Latin word components.

You should already have a basic working knowledge of medical word components; hence, we feel the simplest way to review the components and introduce you to new ones is to provide you with a list. In the following text, we’ll briefly discuss the three major word components, list examples of each, and provide you with their corresponding definitions. Then, we’ll give you a look at how these elements are combined to form medical terms. We start by discussing the word components appearing in the first part of a medical term—prefixes.

005. Identifying medical prefixes

Perhaps the best way to begin a lesson on terminology is to define the meaning of a prefix. A *prefix* is a syllable or group of syllables joined to the beginning of a root word to alter its meaning or create another word. Prefixes are always used in conjunction with a root word or with a root word and

suffix—they can’t stand alone to form a word or term. With this definition fresh in your mind, carefully study the following list of medically related prefixes accompanied by their definitions. The list is arranged in alphabetical order to facilitate review.

Prefix	Definition	Prefix	Definition	Prefix	Definition
a-, an-	absence of	exo-, e-	outside	neo-	New
ab-, abs-	away, from	extra-	Outside, beyond	non-	Not
ad-	to, towards, near	fore-	in front of	Olig-	little
aer-	air	glyco-	Sugar	Pan-	all
Ambi-	both	hemi-	Half	Para-	beside
Ante-, antero-	before, forward	hetero-	Other	Peri-	around
Auto-	self	homo-	Same, similar	Poly-	many, much
bi-	two	hydra-, hydro-	Water	Post-	after
bio-	life	hyp-, hypo-	Below, less	Pre-	before
Brady-	slow	hyper-	Above, excessive	Pro-	before, in front of
Circum-	around	in-	not, in	Pseud-, pseudo-	false
co-, com-, con-	with, together	infra-	Below, beneath	Retro-	backward, behind
Contra-	against, opposed	inter-	Between	Semi-	half
de-	from, not	intra-	Within	Sub-	under
dia-	across, through, apart	iso-	Equal	Super-	above, excess
Deca-	ten	latero-	Side	Supra-	over, above
Demi-	half	leuco-, leuko-	White	Sym-, syn-	with, together
di-	two	macro-	large	tachy-	fast
dis-	negative, apart	mal-	bad, disordered	topo-	place
Dys-	difficult, painful	med-	middle	tox-	poison
Ecto-	on the outside	meg-, mego-	great, large	therm-, thermo-	heat
en-	in	melan-	black	trans-	across, through
Endo-	within	meno-	monthly	tri-	three
epi-	upon	meta-	beyond	ultra-	excess
Erythro-	red	micro-	small	uni-	one
eu-	well, normal	mono-	single		
ex-, e-	away from, without	multi-	many		

There are many more prefixes we could add to this list, but the ones listed should give you a good foundation on which to build your medical vocabulary.

Take a look at one of these prefixes and see how it’s used to make a word. You’re probably familiar with the word *biology*, but did you ever stop to think where this word came from? Actually, biology is a combination of two Greek words, *bio* meaning life, and *log* meaning “the study of or the science

of.” When you combine *bio* and *logy*, you form the word *biology*, which means the science or study of life.

Simple, isn’t it? Biology is just one example of how a prefix is combined with other word components to form a term with a definite meaning. If you study (and memorize) the prefixes in the preceding list, you can break down just about any medical term and figure out what it means. Of course, to fully analyze medical terms and decipher their meaning, you also need to understand the elements of medical language appearing at the tail end of a word—suffixes.

006. Commonly used medical suffixes and their meanings

A *suffix* is defined as a syllable or group of syllables added at the end of a word or word base to change its meaning, to give it grammatical function, or to form a new word. Suffixes may be found in combination with a prefix and a root word or just with a root word. Like prefixes, suffixes can’t be used alone to form a word or term. As with prefixes, let’s look at a list of some common suffixes, along with their meanings, used to form medical terms.

Suffixes	Meaning	Suffixes	Meaning	Suffixes	Meaning
-algia	pain	-graphy	making a recording	-pexy	fastening, fixation
-asis	condition, usually abnormal	-iasis	condition of	-phagia, -phagy	relating to eating and swallowing
-asthenia	weakness	-iatry	treatment of a disease	-phasia	ability to express one’s self
-biotic	living matter	-ism	a condition	-phobia	exaggerated fear
-cele	tumor, cyst, hernia	-itis	Inflammation	-plasty	surgical reshaping or remodeling
-centesis	puncture and aspiration of	-ize	to treat by a special method	-plegia	Paralysis
-cide	causing death	-ilith	stone or calculus	-poiesis	formation of
-cyte	cell	-logy	science or study of	-ptosis	falling, sagging, or dropping down
-desis	binding or fusion	-lysis	destruction of, decomposition	-rhage, -rhagia	excessive flow, breaking/ bursting forth
-ectasis	dilation, stretching	-malacia	softness, softening	-rhaply	a suturing or sewing
-ectomy	removal of	-megaly	enlargement	-rhea or -rhea	flow, discharge
-emia	blood	-meter, -metry	measurement, measuring instrument	-scope	lighted examination instrument
-esthesia	feeling, sensation	-oid	form, shape, resemblance	-scopy	examination using a scope
-gene	production, origin	-oma	tumor	-stasis	a standing still
-genic	producing	-osis	process (disease)	-stomy	to create an opening
-gram	a tracing or mark	-pathy	disease, suffering	-tomy	incision or cutting into
-graph	a writing or record	-penia	lack or reduction in number of	-uria	relating to urine

Although limited, this list contains enough suffixes to strengthen your vocabulary. Now, look at how these suffixes are used to form a medical term. For our example this time, let's try something a bit harder than the one we used to illustrate prefix use. If the word *tracheo* refers to your trachea or throat area, how would you change the word to mean "a surgical incision into the trachea or throat"? If you look through the preceding list, you'll see the suffix *-tomy* (or *-otomy*) means "incision or cutting into." To make the word you want, simply add one of these suffixes to the root word *tracheo*. The term you formed by combining the two elements is *tracheotomy*, which basically means a "surgical incision into the throat or trachea."

You probably noticed there's very little difference between the meanings of some of these suffixes; but, there's a significant difference in the way they're spelled (and used). So, it's very important you pay particular attention to learning the subtle differences. By doing so, you won't confuse and misinterpret a term.

Study these word endings closely and notice how they're used in day-to-day verbal and written communications so you can avoid mixing them up. Also, be ready to see how these suffixes are used later on in this unit when you study common surgical terms.

No discussion of medical terminology would be complete without mentioning the elements that form the heart of medical terms—root words.

007. Root words relating to the human body and its processes

With the definitions of medical prefixes and suffixes fresh in mind, you now have the basis for becoming proficient in the language of your profession. However, to become more familiar with terms that apply to human anatomy and physiology, you need knowledge of commonly used medical root words.

A root word can be defined as the main part or portion of a word from which other words may be formed by the addition of a prefix, a suffix, or both. Very often, a vowel is added when two root words are combined or when a suffix is added to a root word. This *combining vowel* is usually an "o" or an "i," but a "u" is sometimes used.

NOTE: The combining vowel is used to make pronunciation easier when there's no vowel between the two root words or between the root word and suffix.

The following alphabetical list of root words and their definitions relate to the human body and body processes. The most common combining vowel is shown in parentheses.

Root Word	Definition
Abdomin(o)	Abdomen
Acou(i)	Hearing
Aden(o)	Gland
Adren(o)	adrenal gland
Angi(o)	vessel (blood)
Arterio	Artery
Arthr(o)	Joint
Audi(o)	pertaining to hearing
bil(i)	relating to bile
Blephar(o)	relating to an eyelid / eyelash
Brach(i)	Arm

Root Word	Definition
Glyc(o)	sugar
Gyn, gyne, gyneco	woman
hema, hemo, hemat(o)	blood
hepat(o)	liver
hydr(o)	water
hyster(o)	uterus
ile(o), ili(o)	ileum
jejun(o)	jejunum
kerat(o)	cornea
kinesi(o)	movement
laparo	abdomen, loin

Root Word	Definition
pharyng(o)	pharynx
phleb(o)	vein
physio	relating to nature, life
pneum(o)	lung or air
proct(o)	rectum
psych(o)	mind, soul
pulmo	lung
py(o)	pus
pyel(o)	pelvis of the kidney
rect(o)	rectum
ren(i)	kidney

Root Word	Definition
Bronch(o)	pertaining to a bronchus
Calcane(o)	heel
Card(i), cardi(o)	pertaining to the heart
Carp(o)	wrist
Cephal(o), capit	head
Cervic(o)	neck
Chole, chol(o)	bile
Cholecyst	gallbladder
Chondr(o)	cartilage
Col(o)	colon (large intestine)
Colpo	vagina
Cost(o)	rib
crani(o)	skull
cyst(o)	urinary bladder, cyst
cyt(o)	cell
Dactyl(o)	finger or toe
dent(o)	tooth or teeth
Derma	skin
doch(o)	duct
Duoden(o)	duodenum
Encephal(o)	brain
Enter(o)	intestines
fibr(o)	fiber, fibrous
Gastr(o)	stomach
Genu	knee
Gloss(o)	tongue
Gluc(o)	glucose, sweetness

Root Word	Definition
laryng(o)	larynx
latero	side
lip(o)	fat
lith(o)	stone
lymph	watery fluid from special gland
mamm(o)	breast, mammary
mast(o)	breast, mastoid process
mening(o)	membrane
meno	menstruation
metra, metro	uterus
myel(o)	bone marrow, spinal cord
my(o)	muscle
nas(o)	nose
necro	death
nephr(o)	kidney
neur(o)	nerve
ocul(o)	eye
oophor(o)	ovary
ophthalm(o)	eye
opto	relating to vision
orchi(o)	testicle
orth(o)	straight, normal
os	bone or opening
oste(o)	bone
ot(o)	ear
path(o)	relating to disease
ped(o)	Child, foot

Root Word	Definition
rhin(o)	nose
sacro	sacrum (vertebra)
salping(o)	tube (uterine or auditory)
sarc(o)	flesh (skeletal muscle tissue)
splen(o)	spleen
spondyl(o)	vertebrae, spine
sten(o)	narrow, constriction
stern(o)	sternum
stomato	mouth
teno, tenonto	tendon
therm(o)	heat
thoraco	chest, thorax
thromb(o)	clot, thrombus
thyr(o)	thyroid gland
toxos	poison
toxic(o)	poison, poisonous
trachel(o)	cervix
trache(o)	trachea
uretero	ureters
urethro	urethra
ur(o), urin(o)	relating to urine or urinary organs
uter(o)	uterus
vas(o)	blood vessel, vas deferens
ven(o)	vein
ventri, ventro	abdomen
vertebr(o)	spine, vertebrae
vesico	urinary bladder

As was the case with the prefixes and suffixes we previously listed, this list of root words isn't all-inclusive. It does, however, contain most of the root words you'll encounter in the pharmacy.

You probably noticed that many of these root words don't look or sound like the subjects they describe. The reason for this is that most of them are derived from ancient Greek and Latin, as are the

other elements we discussed. Unless you're well versed in these languages, you're going to have to memorize them.

If you take the time to learn the elements of medical terminology presented in this section, you should be able to look at most medical terms and figure out what they mean (or at least be fairly close).

When you put all these word components together in different combinations, you formulate the words and expressions that are an integral part of everyday communication between members of the health care delivery team. Since your duties will involve working through out the medical treatment facility (MTF), it's important you be familiar with some of the more common terms used to describe medical procedures. You also need to know something about the shorthand medical folks use when writing comments on patients' charts. In the next section you'll take a closer look at these subjects.

008. Common medical terms

The following is a list of commonly used medical terms. You'll see these terms frequently, and need to know what they mean in relationship to our patient's pharmaceutical care. The definitions given here are brief. Some of the terms will be or already have been explained in greater detail.

Term	Definition
Acidosis	Acid/base imbalance causing the blood and body tissues to become excessively acidic.
Acute	A severe condition, rising rapidly to a peak and then subsiding.
Additive (parenteral)	An addition of an active ingredient to a solution that's intended for intravenous administration or irrigation.
Alkalosis	Acid/base imbalance causing the blood and body tissues to become excessively alkaline (basic).
Allergen	An agent that provokes the symptoms of an allergy.
Allergy	An abnormal reaction to a substance, situation, or physical state.
Ambulatory patient	A patient who is able to walk and isn't restricted to bed.
Anabolism	The body process during which proteins are synthesized and tissues are formed.
Analgesic	A substance that relieves pain.
Anaphylaxis	A hypersensitivity reaction that's immediate, shock-like, and possibly fatal.
anesthetic	A drug used to decrease sensation.
aneurysm	A dilation or bulging out of a blood vessel wall.
antipruritic	A drug that relieves itch.
antepartum	Before the onset of childbirth.
antibiotic	A substance that's able to kill or inhibit the growth of bacteria or other microorganisms.
anticoagulant	A drug that prevents or delays coagulation or clotting of blood; a "blood thinner."
antiflatulent	A drug that facilitates expulsion of gas from the gastrointestinal tract.
antigen	An agent that stimulates antibody formation.
antineoplastic	A substance that prevents the development or spread of tumor cells.
antipyretic	A drug that reduces fever.
antiseptic	An agent that inhibits the growth of microorganisms but doesn't necessarily kill them.
antitoxin	A specific agent neutralizing a poison or toxin.
antitussive	A drug used for the relief of cough.
arrhythmia	An abnormal, irregular heart beat.
aseptic technique	A method of preparation that will prevent contamination of a site (e.g., wound) or product (e.g., IV admixture).

Term	Definition
bactericide	An agent capable of killing bacteria.
bacteriostat	An agent that inhibits the growth of bacteria.
benign	Not malignant or invasive.
biopsy	Excision of a small piece of tissue for diagnostic purposes.
bradycardia	Slow heart rate.
buccal	Between the gum and cheek.
carcinogen	Any substance that causes cancer.
cathartic	A drug used to produce evacuation of the bowel.
chemotherapy	Treatment of a condition with drugs. Currently used in reference to the treatment of cancer.
chronic	Of long duration or frequent recurrence.
coagulation	Blood clotting process.
creatinine clearance	A measure of renal function.
decongestant	A drug used to open the air passages of the nose and lungs.
diastolic pressure	The force exerted by the blood on the blood vessels when the ventricles of the heart are in a state of rest before systole.
diluent	An agent that dilutes or reconstitutes a solution or mixture.
diuretic	A drug used to increase urinary output; "water pill."
electrocardiogram	A graphic record of the heart's action by electronic measurement.
electroencephalogram	A tracing or electronic recording of brain waves.
embolism	A traveling blood clot that may deposit in a vessel and obstruct flow through that vessel.
etiology	The cause(s) of a disease.
expectorant	A drug that promotes the secretion and excretion of mucus from the lungs and trachea.
febrile	Body temperature above normal.
fibrillation	Rapid, ineffectual heartbeat.
hemorrhage	Severe bleeding.
hypnotic	A drug used to induce sleep.
infusion	The slow injection of a solution into a vein, subcutaneous tissue, or other tissue.
intra dermal	Situated or applied within the skin.
intramuscular	Within the muscle.
intrathecal	Within the subdural space of the spinal cord.
iontophoresis	Introduction of medication into the tissue by means of an electric current.
jaundice	Yellow appearance of skin and mucous membranes resulting from the deposition of bile pigment.
malignant	A type of tumor that invades healthy tissue
medication administration record	A record containing information about the patient's medication and its frequency of administration.
meninges	The membrane that surrounds the brain and spinal cord.
metastasis	The spread of disease from one organ to another.
milliequivalent (mEq)	One-thousandth of an equivalent weight.
miotic	A drug that causes constriction of the pupil.
mucolytic	A substance that liquifies, dissolves, or digests mucus.
mydriatic	An agent that dilates the pupil of the eye.
myocardial infarction (MI)	Injury to the heart muscle (myocardium) due to inadequate oxygen supply caused by the occlusion of a coronary artery.

Term	Definition
palliative	A treatment that provides relief but no cure for a condition.
pathogen	Any disease-producing organism.
pathology	That branch of medicine concerned with the essential nature of disease, especially the structural and functional changes in tissues caused by the disease process.
pharmacogenetics	The study of the relationship between heredity and response to drugs.
pharmacognosy	The study of therapeutic agents derived from natural sources, e.g., plants.
pharmacokinetics	The study of bodily absorption, distribution, metabolism, and excretion of drugs.
pharmacology	The study of the action of drugs on the body.
pharmacotherapeutics	Pertaining to the use of drugs in the prevention and/or treatment of disease.
postpartum	Occurring after childbirth, or delivery.
prognosis	The expected outcome of the course of the disease.
subcutaneous	Under the skin.
sublingual	Under the tongue.
symptom	Subjective evidence of a disease; evidence of disease as perceived the patient.
syncope	Fainting; a transient loss of consciousness due to inadequate blood flow to the brain.
syndrome	A group of signs and symptoms that characterize a particular abnormality.
synergism	A joint action of agents in which the total effect of the combination is greater than the sum of their individual independent effects.
systolic	The force exerted by the blood when the ventricles are in a state of contraction.
tachycardia	Rapid heart rate.
toxic	Resembling, or caused by poison.
urticaria	Eruption of rash associated with severe itching.
valence	Those electrons associated with bonds between elements.
ventricular fibrillation	Rapid ineffectual action of the ventricle of the heart.

009. Common medical/pharmacy abbreviations

Most prescribers and pharmacy personnel use abbreviations instead of spelling out long terminology or frequently used terminology. The following list isn't all-inclusive, and you may have seen some of the abbreviations in previous lessons. If not, you'll see them either on prescriptions or inpatient doctor's orders.

Abbreviation	Term
ac; AC	before meals
achs; AC&HS	before meals and at bedtime
AD	right ear
ADR	adverse drug reaction
AS	left ear
ASAP	as soon as possible
AU	both ears
CNS	central nervous system
COPD	chronic obstructive pulmonary disease
diag. or Dx	diagnosis
gtt	drop

Abbreviation	Term
NPO	nothing by mouth
OD	right eye
oint; ung	Ointment
OS	left eye
OTC	over the counter
OU	both eyes
pc; PC	after meals
po; P.O.	by mouth
PR	rectally (per rectum)
prn; PRN	as needed
Q	Every

Abbreviation	Term
hs; qhs	bedtime
Hx	history
IM	intramuscular
IV	intravenous
IVP	intravenous push
IVPB	intravenous piggyback
kg	kilogram
L or l	liter
mcg; ug; Og	microgram
MDI	metered dose inhaler
mEq	milliequivalent
MR (X 1, X 2)	may repeat (time 1 dose, 2 doses)
N&V; N/V	nausea and vomiting
NKDA	no known drug allergies
non rep (NR)	do not repeat

Abbreviation	Term
Qam	every morning
Qd	every day
Qod	every other day
Qpm	every evening
Qs	quantity sufficient
R/O	rule out
SC; SQ; subQ	Subcutaneous
Sig	let it be imprinted, label
SL	Sublingual
$\frac{1}{2}$ ss; ss	one-half
Stat	immediately and once only
Tid	three times daily
Tiw	three times weekly
Tx	Treatment
ut dict	as directed

010. Commonly used apothecary symbols

Not all symbols and abbreviations are absolute. Some of them may have more than one meaning when used in different contexts. If you have any doubt as to their meaning, consult your supervisor or pharmacist for clarification. The following list is some of the more commonly used apothecary symbols.

Symbol	Term	Symbol	Term
℥	dram, teaspoonful	>	is greater than
℥	ounce	<	is less than
℥ss	half ounce or one tablespoonful	↑	elevated or increase
℥m	minim	↓	depressed or decrease
=	equal	%	Percent
♀	female	▲	Change
♂	male		

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

005. Identifying medical prefixes

1. What's a prefix?
2. When are prefixes used alone to define a word or system?

3. Match the prefix in column A to the appropriate definition in column B. Each definition may be used once, more than once, or not at all.

<i>Column A</i>	<i>Column B</i>
____ (1) An	a. with, together
____ (2) Bio	b. white
____ (3) Dys	c. between
____ (4) Erythro	d. difficult
____ (5) Glyco	e. red
____ (6) Infra	f. life
____ (7) Leuko	g. little
____ (8) Melan	h. absence of
____ (9) Olig	i. black
____ (10) Para	j. sugar
____ (11) Retro	k. excess
____ (12) Supra	l. below, beneath
____ (13) Tachy	m. beside
____ (14) Ultra	n. over, above
	o. backward, behind
	p. fast

006. Commonly used medical suffixes and their meanings

1. What's a suffix?
2. Match the suffix in column A with the appropriate definition in column B. Each definition may be used once, more than once, or not at all.

<i>Column A</i>	<i>Column B</i>
____ (1) -algia.	a. To create an opening.
____ (2) -centesis.	b. Incision or cutting into.
____ (3) -ectomy.	c. Puncture and aspiration of.
____ (4) -esthesia.	d. Removal of.
____ (5) -lysis.	e. Act of examining.
____ (6) -megaly.	f. A suturing or sewing together.
____ (7) -pexy.	g. Excessive flow.
____ (8) -plasty.	h. Surgical reshaping or remodeling.
____ (9) -rhagia.	i. Fastening/fixation.
____ (10) -rhaply.	j. Decomposition.
____ (11) -scopy.	k. Formation of.
____ (12) -stasis.	l. Enlargement.
____ (13) -stomy.	m. Paralysis.
____ (14) -tomy.	n. A standing still.
	o. Feeling, sensation.
	p. Pain.

007. Root words relating to the human body and its processes

1. What's a root word?
2. What's the purpose of a combining vowel?

3. Match the root word in column A with the appropriate definition in column B. Each definition may be used once, more than once, or not at all.

<i>Column A</i>	<i>Column B</i>
____ (1) acou(i).	a. Vein.
____ (2) bronch(o).	b. Hearing.
____ (3) cardi(i).	c. Pertaining to the heart.
____ (4) chondr(o).	d. Pertaining to a bronchus or bronchi.
____ (5) colpo.	e. Skin.
____ (6) cyt(o).	f. Cell.
____ (7) dactyl(o).	g. Blood.
____ (8) derma.	h. Muscle.
____ (9) enter(o).	i. Stone.
____ (10) hemat(o).	j. Bone.
____ (11) kerat(o).	k. Vertebrae, spine.
____ (12) lith(o).	l. Cartilage.
____ (13) my(o).	m. Finger or toe.
____ (14) oste(o).	n. Intestines.
____ (15) spondyl(o).	o. Cervix.
____ (16) trachel(o).	p. Rib.
____ (17) ven(o).	q. Vagina.
____ (18) vesic(o).	r. Liver.
	s. Cornea.
	t. Urinary bladder.

008. Common medical terms

1. Define acute.
2. Define anabolism.
3. Define buccal.
4. Define coagulation.
5. Define mucolytic.
6. Define pharmacognosy.
7. Define synergism.

009. Common medical/pharmacy abbreviations

1. Define the following abbreviations:

- a. ADR.
- b. AU.
- c. HX.
- d. mEq.
- e. qs.

010. Commonly used apothecary symbols

- 1. What symbol is used to represent “is greater than?”
- 2. What symbol is used to represent “change?”

2-2. Drug-Delivery Systems

In this section you’ll study several controlled drug-delivery systems. The topics presented will provide information on methodology and the advantages these systems have over other drug-delivery systems. Once you complete this section, you should be aware of the importance of drug-delivery to the site of pharmacological action and have a appreciation of how these systems increase patient compliance and convenience.

011. Drug delivery

If the condition to be treated is at a directly available site, the drug is applied to the site where it can perform its pharmacological actions. Some examples of direct drug application are in the ear or eye, or on the skin. There are many advantages to applying a drug directly to its site of pharmacological action, but this isn’t always possible. If the site of action is located inside the body, the blood is generally used as a method of drug delivery. One major problem with this is that the blood carries drugs to all parts of the body. This could cause a series of other pharmacological actions known as side effects.

Historically, drugs have been delivered in the systemic circulation by giving them in two basic methods:

- 1. Orally.
- 2. Injecting under the skin, into a muscle, or directly into a blood vein.

Oral route

Drug delivery using the oral route (gastrointestinal) can present a series of problems that are unique and often times unacceptable. These problems are caused by parameters, such as the following:

- A very acidic environment in the stomach.
- Stomach emptying time.
- Method by which the drug is absorbed.
- Drug degradation.
- First-pass effect.

NOTE: First-pass effect refers to the metabolism of a drug by the gut or liver after oral absorption but before the drug has made one pass through the systemic circulation.

- The presence or absence of food and fluids that make the oral route of delivery unpredictable and unacceptable at times.

Another inherent characteristic of the oral route for single-dose drug forms is it produces peaks (high concentration) and troughs (low concentration) of the drug's concentration in the blood. Of equal or greater concern is the compliance of an outpatient in taking the drug at the appropriate time, and in the prescribed amount and manner (e.g., with or without food, with sufficient liquids).

Injection

When drugs are injected, they bypass the gastrointestinal tract, but they present another set of complications:

- Sterility.
- The use of a hypodermic syringe.
- Injection techniques.
- Chance of infection.
- Multiple injections for chronic conditions.

All these factors make injectable drugs applicable to only a few individuals outside the hospital environment. These outpatients need to be trained with proper injection techniques and they need confidence in their ability to deliver the drugs by the injectable method.

Advantages of controlled drug delivery

Due to the problems with traditional drug delivery, new methods are intensively being studied and researched by different product-development groups throughout the United States. Some of the newer delivery systems strive to deliver the drug directly into the systemic circulation at a constant rate and over an extended period of time. Still other methods deliver the drug directly to the site of action within the body without even producing significant concentrations of the drug in the systemic circulation.

At present, there are drug-delivery techniques being developed that aren't (or only on a limited bases) absorbed in the gastrointestinal tract. These systems are challenged to deliver the drug to the proper site, at the right concentration, and at the right time.

Drug-delivery goals

Production—both current and future—of new therapeutic agents (especially biological drugs being developed from the biotechnology field) mandate new drug-delivery systems. These systems are expected to accomplish the following:

- Maximize their therapeutic effects.
- Reduce their toxic effects.
- Reduce the total dose needed to produce the desired response.

012. Controlled drug-delivery systems

In this lesson you'll study a wide variety of controlled drug-delivery systems:

- Biodegradable polymers.
- Ophthalmic drug-delivery.
- Microemulsions.
- Liposomes.
- Transdermal delivery systems.

In addition to those listed, you'll take a brief look at some of the state-of-the-art systems currently under development.

Biodegradable polymers

The term *biodegradable* means the system will degrade or breakdown in a living organism. Sometimes these systems are termed "erodible drug-delivery systems." The systems' drug release is accomplished by the surface eroding away after it's injected or implanted into a living organism. These devices are formulated from various *polymers* (plastics) that are susceptible to surface degradation by biological fluids. Drugs are incorporated into the system during the original formation of the polymer; therefore, *homogeneous* dispersion of the drug exists throughout the system.

These biodegradable drug-delivery systems are formed from different polymers. The polymers vary in their rate of surface erosion so a system can be tailor made to release a drug at a predetermined rate. In addition to being biodegradable, the polymers used in these systems must be *bioacceptable*; that is, they don't cause tissue damage and are easily eliminated after degradation.

Drug polymer systems

Drug polymer systems are formulated, reduced to the optimal size, and injected into a muscle. These systems have an advantage over conventional intramuscular drug injections. The drug polymer systems possess a slow releasing characteristic of the drug and a prolonged length of time for drug delivery.

Some commercial polymer systems are now available for companies to purchase and utilize as drug-delivery systems for drugs they manufacture or have previously procured; however, there are some problems with these systems. The three major problems are as follows:

1. They must be injected.
2. They're nonretrievable.
3. They may decrease the rate of drug release as the surface of the device becomes smaller.

Taking these problems into account, biodegradable systems still offer a dynamic and exciting method of delivery of drugs.

Polymer drug classes

Some of the drug classes that have been and are now being tested are as follows:

- Narcotic antagonists.
- Prostaglandins.
- Immunosuppressants.
- Contraceptives.

- Antibiotics.
- Anti-inflammatory agents.
- Antihypertensives.
- Anticonvulsants.
- Antitumor drugs.
- Nasal dosage forms

Nasal route administration

Drug administration using the nasal route raises a great deal of interest for the pharmacologically active peptides and proteins. These large molecular weight compounds don't cross biological membranes to an appreciable degree; therefore, absorption enhancers must be used to increase their absorption. Various enhancers have been utilized. The following are examples:

- Surfactants.
- Bile salts.
- Chelating compounds.

Nasal drug-delivery systems use vehicles as well as enhancers. These vehicles and enhancers must be safe and nonirritating. Some enhancers also protect the proteins or peptides from undergoing *hydrolysis* or degradation before they're absorbed.

Currently, nasal drug-delivery systems using bile salts and insulin are undergoing human clinical trials. There's also sound documentation in regards to nasal absorption of vitamin B₁₂. When compared to vitamin B₁₂ given orally, the nasal administration of vitamin B₁₂ produces a substantially higher blood level and an increased rate of absorption for comparable dosages. In addition, growth hormones, endorphins, secretin, and hypothalamic releasing hormones are currently being tested in nasal drug-delivery systems.

Ophthalmic drug delivery

An ocular system with the proper formulation is believed to be a viable alternative site for the absorption of specific compounds that are degraded or not absorbed from the oral route. However, conventional ocular solutions, suspensions, or ointments are relatively ineffective as systemic drug-delivery systems. This is due to less than 10 percent drug absorption across the cornea of the eye. In addition, the eye's cornea is very lipophilic (fat loving). Moreover, drugs are diluted by tears and consequently lost through the nasal passages; thus, aqueous solutions of drugs are lost rapidly.

Currently, the ophthalmic drug-delivery method is more an area of curiosity, although it's certainly a method with high potential. At this time, several methods for improved absorption of drugs applied to the eye are under investigation:

1. Nanoparticles (very small suspended particles).
2. Gels.
3. Ocular inserts.
4. Latex systems.
5. Bioadhesives.

There are also some more controversial methods. They add absorption enhancers that change the integrity of the cornea and increase the absorption of proteins and peptides. These methods dramatically increase the absorption of drugs in the eye and also affect nasal passage draining. The majority of the absorption from this site is most likely in the nasal mucosa.

Microemulsions

Remember from previous training that an emulsion is a dispersion of small droplets of a liquid in another liquid in which it's insoluble. A microemulsion is an emulsion where the droplets of the dispersed liquid are of an extremely small size. Most pharmaceutical emulsions are water in oil or oil in water, with an appearance similar to milk (a natural oil in water emulsion). Emulsions aren't clear due to the relative large size of the dispersed droplet. On the other hand, a microemulsion is clear. This is because the dispersed droplet is smaller than a wavelength of ordinary light.

There are several unique properties of microemulsions. There many advantages are as follows:

1. May be given orally or applied topically.
2. Greatly improve the absorption of drug that would otherwise be poorly absorbed. In most cases, the absorption of a drug incorporated within a microemulsion is rapid and complete.
3. Are excellent for lipophilic drugs.
4. Steroids, hormones, diuretics, anti-inflammatory agents, vitamin A and D (fat-soluble vitamins) all show an increase in absorption when given in a microemulsion.
5. Mask the taste of drugs. When a lipophilic drug is incorporated in dispersed oil droplets and the aqueous liquid flavored, the drug can't be tasted when the microemulsion is taken orally.
6. Work well topically for a wide variety of substances. For example, steroids, anesthetics, and antibiotics are more effective in their penetration through the skin in a microemulsion.
7. Counterirritants can be used topically at a lower concentration and produce the same pharmacological response.
8. The topical application of compounds that produce a feeling or sensation of warmth, like methyl salicylate, are released and absorbed more effectively. They permeate deeper into the skin, and have been found to be safer when incorporated into a microemulsion.
9. These systems most definitely afford an improved method of obtaining drug absorption through biological tissue, at the same time, decreasing many side effects.

Liposomes

Small concentric or linear-shaped membranes that are closed and can entrap substances within their interior are known as liposomes. Liposomes are represented by bimolecular sheets of molecules surrounding the entrapped drug. A very descriptive name for these substances is "molecular Trojan horse." Liposomes are formed with a positive, negative, or no surface charge. In addition, they can be prepared to accommodate a wide variety of water- or lipid-soluble compounds. The bimolecular sheets of molecules that compose the liposome can be formed to securely entrap the drug and not release it until the liposome wall is disrupted. The composition, as well as the nature of the liposome environment, determines the release of the entrapped substance.

To explain this a little further, say a liposome will carry a drug through biological membranes and not release it until it reaches an organ that will disrupt the bimolecular structure of the liposome wall. If the liposome can be targeted to the site of the pharmacological action of the entrapped drug, then drug delivery is possible to a specific internal site. Preferentially, liposomes are taken up by the liver, spleen, lungs, bone marrow, and kidneys. There's relatively easy drug delivery to these sites.

To target liposomes to other areas, a homing macromolecule is selectively attached to its surface. These macromolecules cause the liposome and its entrapped drug to migrate to a specific site. The selection of a proper homing molecule and the surface attachment of the liposome could lead to problems; however, some of these systems are very effective. The following seven therapeutic classes have achieved success:

1. Antimicrobials.
2. Antifungals.

3. Antiparasitics.
4. Antimalarials.
5. Immunomodulators (antitumor drugs).
6. Enzymes.
7. Antigens (toxoids).

Currently, there are various proteins and peptides under investigation:

1. Insulin.
2. Various chemotherapy agents, including methotrexate, bleomycin, cytarabine, and actinomycin.

Liposome entrapped chemotherapy agents are especially significant because this allows for delivery of an anticancer drug directly to the tumor site at a concentration high enough to destroy the tumor but not create a blood concentration that's injurious to the host. Generally speaking, this isn't currently possible; however, research into the proper drug-carrier combination selection and attachment of specific homing molecules to deliver the system to the target will make large-scale clinical use of these systems possible.

Transdermal delivery systems

The first transdermal delivery system was used in 1971. Since 1971, a large number of drugs have been researched and many of these are currently available in transdermal delivery devices. For example, nitroglycerin, scopolomine, estradiol, and nicotine. Now, many patients are routinely using these transdermal delivery devices.

Most transdermal delivery devices are applied to the skin—where drug release out of the device and presentation to the surface of the skin for absorption occur. The effectiveness of these drugs is validated by drug absorption through the skin once it's released from the device. Many drugs will penetrate the skin very rapidly, some sporadically, and others not at all. The development of methods to increase drug penetration through the skin is a major challenge to transdermal drug delivery. The skin physically acts as a protectant for the body and, therefore, is impermeable to most substances.

There are several ways of obtaining permeation promotion through the skin. For example, permeation promoters can be used. These are agents that soften and swell the external layer of the skin, thereby increasing drug permeation. At other times, oils, ethanol, and polyethyleneglycols have been used. In some cases, alcohols and organic solvents have been used to change the integrity of the skin and allow for drug permeation. Various amino acids have also been tried. These agents penetrate the skin and, in so doing, will also cause a drug to permeate or be carried along with its absorption.

Of more current development is the use of *iontophoresis*, whereby an electrical current is used to drive a drug through the skin. Iontophoresis uses a battery and causes an electrical current to flow through the skin. Ionized (possess a charge) drugs will migrate under the influence of the voltage gradient through the skin and into systemic circulation. These iontophoretic devices have been reduced to the size of a skin patch through the use of microelectronics and microcircuitry. The battery is built into and is an integral part of the device.

Electrico-osmotic transport is a second approach to the use of an electrical current. These devices utilize a very low electrical current (lower than that of iontophoresis) and induce an electro-osmotic transport of fluids and their solutes across the skin. The device generates a continuous weak electrical current which is below the sensitivity threshold of the skin. The current creates a transport of ions either away from or toward the device. Therefore, dissolved drugs, as well as bulk transport of liquids and ions, can be achieved.

Transportation of compounds that weren't deliverable before the use of an electrical current is now possible. This was made possible because a large number of critical barriers to the transdermal transportation of drugs was defeated by iontophoresis or electro-osmotic transport. For example, the

transdermal delivery of large proteins and polypeptides is now possible. With iontophoresis or electro-osmotic transport, the thickness of the skin and skin permeability changes become less important. One such patented device shows very favorable results for several drugs, to include propranolol, hydromorphone, and insulin.

From our discussion, you can see that transdermal drug-delivery systems show much promise for effective, continuous, and reproducible drug delivery. These systems are very usable, and with the electrical component, complex proteins, like insulin, can be delivered systemically through the skin.

More state-of-the-art systems

At the time of this writing, there are other very sophisticated devices under evaluation. These include, but aren't limited to the systems shown in this table:

System/Device	Explanation
Self-regulated drug-delivery systems	Drug release is based on a physiological parameter. For example, insulin release is based upon the concentration of glucose in the blood.
Magnetic devices	Drug release is based on the presence or absence of a magnetic field that can be controlled externally.
Programmable devices	A device can be implanted under the skin to release a drug at a predetermined rate that's programmed into the device.
Microsponges	Entrapment devices for drugs may deliver drugs in a manner similar to liposomes. Drug-delivery is based upon osmotic pressure relationships.

Pharmacy practice application

Other nonconventional drug-delivery systems, plus the systems discussed in this lesson, will eventually afford the flexibility necessary to achieve optimal drug activity on an individual basis. Keep in mind, these systems will necessitate more meticulous patient monitoring and a better understanding by all medical and paramedical personnel of how these devices operate.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

011. Drug delivery

1. What's one major problem with using blood as a method of drug delivery?
2. List the parameters associated with oral route drug delivery.
3. Explain the term "first pass effect."
4. List the challenges facing controlled drug-delivery systems.

012. Controlled drug-delivery systems

1. What does the term *biodegradable* mean?

2. What type of ophthalmic solutions contain drugs that are lost rapidly after administration?
3. What's a microemulsion?
4. What are liposomes?
5. What are permeation promoters?
6. What's the basis of drug release in a self-regulated drug-delivery system?

Answers to Self-Test Questions

005

1. A syllable or group of syllables joined to the beginning of another word to alter its meaning or create another word.
2. Never.
3. (1) h; (2) f; (3) d; (4) e; (5) j; (6) l; (7) b; (8) i; (9) g; (10) m; (11) o; (12) n; (13) p; (14) k.

006

1. A syllable or group of syllables added at the end of a word or word's base to change its meaning, give it grammatical function, or form a new word.
2. (1) p; (2) c; (3) d; (4) o; (5) j; (6) l; (7) i; (8) h; (9) g; (10) f; (11) e; (12) n; (13) a; (14) b.

007

1. The main part or portion of a word from which other words may be formed by addition of a prefix and/or suffix.
2. Used to make pronunciation easier when there's nothing between the two root words, or between the root word and suffix.
3. (1) b; (2) d; (3) c; (4) l; (5) q; (6) f; (7) m; (8) e; (9) n; (10) g; (11) s; (12) i; (13) h; (14) j; (15) k; (16) o; (17) a; (18) t.

008

1. A severe condition, rising rapidly to a peak and then subsiding.
2. The body process during which proteins are synthesized and tissues are formed.
3. Between the gum and cheek.
4. Blood clotting process.
5. A substance that liquifies, dissolves, or digests mucus.
6. The study of therapeutic agents derived from natural sources, e.g., plants.
7. A joint action of agents in which the total effect of the combination is greater than the sum of their individual independent effects.

009

1.
 - a. Adverse drug reaction
 - b. Both ears
 - c. History
 - d. Milliequivalent
 - e. Quantity sufficient

010

1. >
2. ▲

011

1. Blood carries drugs to all parts of the body. This could cause a series of other pharmacological actions known as side effects.
3.
 - (1) A very acidic environment in the stomach.
 - (2) Stomach emptying time.
 - (3) Method by which the drug is absorbed.
 - (4) Drug degradation.
 - (5) First pass effect.
 - (6) The presence or absence of food and fluids make the oral route of delivery unpredictable and unacceptable at times.
3. Refers to the metabolism of a drug by the gut or liver after oral absorption but before the drug has made one pass through the systemic circulation.
4. Delivering the drug to the proper site, at the right concentration, and at the right time.

012

1. The system will degrade or breakdown in a living organism.
2. Aqueous solutions.
3. An emulsion where the droplets of the dispersed liquid are of an extremely small size.
4. Small concentric or linear-shaped membranes that are closed and can entrap substances within their interior.
5. Agents that soften and swell the external layer of the skin, thereby increasing drug permeation.
6. Physiological parameter (e.g., glucose blood level).

Do the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter.

14. (005) What does the prefix “dys” mean?
 - a. Half.
 - b. Apart.
 - c. Difficult.
 - d. Negative.
15. (005) What does the prefix “meta” mean?
 - a. Above.
 - b. Middle.
 - c. Behind.
 - d. Beyond.
16. (006) What does the suffix “oid” mean?
 - a. Flow.
 - b. Form.
 - c. Standing still.
 - d. Causing death.
17. (006) What does the suffix “esthesia” mean?
 - a. Fusion.
 - b. Fastening.
 - c. Sensation.
 - d. Swallowing.
18. (007) What does the root word “acou(i)” mean?
 - a. Arm.
 - b. Life.
 - c. Stone.
 - d. Hearing.
19. (007) What does the root word “cyt(o)” mean?
 - a. Cell.
 - b. Rib.
 - c. Heat.
 - d. Head.
20. (008) Which medical term means “cause of a disease?”
 - a. Benign.
 - b. Antigen.
 - c. Etiology.
 - d. Embolism.
21. (008) Which term describes an acid or base imbalance that causes the blood and body tissues to become excessively alkaline (basic)?
 - a. Acidosis.
 - b. Alkalosis.
 - c. Anabolism.
 - d. Aneurysm.

22. (008) Which term describes the spread of a disease from one organ to another?
- Miotic.
 - Metastasis.
 - Pathology.
 - Synergism.
23. (009) The abbreviation NPO on a patient's chart means
- nothing post-operation.
 - note provider orders.
 - no penicillin ordered.
 - nothing by mouth.
24. (009) The abbreviation for "before meals and at bedtime" is
- AC&HS.
 - AC&PC.
 - AS&PC.
 - PC&HS.
25. (010) What apothecary symbol is used to indicate "change?"
- ▲.
 - >.
 - <.
 - ▼.
26. (010) What apothecary symbol is used to indicate "teaspoonful?"
- ℥.
 - ℥ss.
 - ℥.
 - ℥.
27. (011) Which is an example of a "direct drug application?"
- Intramuscular.
 - Intravenous.
 - In the ear.
 - Oral.
28. (011) Which is a problem when a drug is delivered through the oral route?
- First pass effect.
 - High risk of side effects.
 - Slow onset of therapeutic effect.
 - Patient inability to swallow tablets.
29. (012) It is important that biodegradable polymers used in controlled drug delivery be bioacceptable so that
- they do not cause tissue damage.
 - they will not interact with other drugs.
 - drugs can easily be incorporated into them.
 - drugs will be properly released into the bloodstream.
30. (012) What method of drug administration is used for drug polymer systems?
- Intramuscular.
 - Intravenous.
 - In the ear.
 - Oral.

31. (012) One *advantage* of giving drugs orally in microemulsions is that the
- a. drug is unaffected by stomach acid.
 - b. drug action is enhanced.
 - c. drug is absorbed slower.
 - d. taste is masked.
32. (012) What drug delivery system can carry a drug through biological membranes and not release the drug until it reaches an organ?
- a. Biodegradable polymer.
 - b. Microemulsion.
 - c. Transdermal.
 - d. Liposome.

Student Notes

Unit 3. Actions and Uses of Drugs and Basic Biopharmaceutics

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IN this unit you'll start your journey into the world of pharmacology. First, you'll look at the actions and uses of drugs. This will include discussions about the science of pharmacology, the routes of administration, the factors affecting drug activity, and the classification of drugs. Then, you'll turn your attention to basic biopharmaceutics. You'll begin with an introduction to this fascinating subject. From here, you'll look at the different aspects of drug absorption, drug disposition, elementary pharmacokinetics, and therapeutic drug monitoring.

3–1. Action and Uses of Drugs

We've designed this section to familiarize you with some of the fundamental aspects of applied pharmacology and the role of the clinical pharmacist and the pharmacy technician in applying these concepts to the pharmacy practice. As we develop these concepts, we'll include examples of drugs that are actually used in clinical medicine. The last lesson in this section is very important because it provides information for various drug categories and their clinical use. The information is so important that you need to commit it to memory.

013. The science of pharmacology

In order for you to more effectively aid the pharmacist in his or her clinical role, you need a basic understanding of the fundamental aspects of *Pharmacology*, defined as “*the science that deals with the nature of chemical substances called drugs and their interactions with other drugs, foods, or the biochemical systems of the body for the purpose of modifying disease states.*”

That's a very scientific definition. A more practical one might be “*As a drug is administered in sufficient quantity, to a specific patient, in a particular time course (dosing interval), it can obtain a high enough tissue level in the body to favorably reverse a pathological process, thereby alleviating the symptoms of disease.*”

As you'll find out later in this section, drugs can modify disease in a variety of ways. Here are some examples of what drugs can do:

- Totally reverse the symptoms of congestive heart failure by improving the contractility of the heart (digoxin).
- Destroy cancer cells, producing remissions in neoplastic disease (cisplatin).
- Alleviate the symptoms of infection by destroying microorganisms (penicillin).
- Provide long-term survival by lowering blood pressure (methyldopa).

Nevertheless, in order for the drug to reverse the state of the diseased tissue, it must gain entry into the body and be delivered by the circulatory system in sufficient quantity to the diseased tissue site. Due to the fact that the circulation also bathes many other body tissues besides the one being treated, it isn't extraordinary that a cardiac drug could also affect other sites in the body, such as the eye or the kidney. Therefore, we can divide different drug effects into two classes:

1. Those that are intended or therapeutic (such as cardiac effects, in this instance).
2. Those that aren't intended or side effects (such as the eye or the kidney).

When the side effects are undesirable, they're further subclassified as adverse effects. It's safe to say that all drugs have specific beneficial responses for which they have been designed and side effects that must be accepted as the consequence of drug therapy. Normally, these side effects can be prevented by carefully adjusting the patient's drug dosage. Because of today's very potent medications, the prescriber must often weigh the benefits of treatment to the risks of medication side effects (e.g., cancer chemotherapeutic agents).

Keep in mind that all side effects aren't undesirable, and there are instances where the side effects may become as useful as the therapeutic response desired (e.g., diphenhydramine produces drowsiness and, consequently, is useful as a sedative in pediatric patients).

The function of today's clinical pharmacist is to assist prescribers in providing optimum medical care to their patients, in particular, rational drug treatment. Bearing in mind the thousands of drug products and dosage forms currently available on the market, the role of the pharmacist as a provider of drug information to prescribers and a dispenser of drug products to patients has become exceedingly complex and, likewise, rewarding. Because we want to provide a high caliber of care, you, as a pharmacy technician are an important individual. You're needed to optimize the efficiency of the pharmacist to assist the prescribers in the execution of drug orders.

One very important question in regard to drug usage should always be, "How seriously ill is the patient?" The answer to this will tell the provider how quickly the desired drug action is required. For example, intravenous drugs with their almost immediate onset of action are used for critical situations requiring immediate attention. On the other hand, orally administered products with their slow, gradual effects are used for less-critical situations or where long-term management is needed.

Frequently, common sense enters into the selection process of a proper dosage form of a drug. Here are some examples:

- An oral product administration to an unconscious patient wouldn't be desirable; instead, the injectable route is preferable.
- A patient with nausea and vomiting wouldn't be administered an oral product. In this case, the injectable or rectal routes are more appropriate.
- In an emergency state, an oral drug with slow onset of action wouldn't be useful. Here, the injectable route would be used.

From your (the pharmacy journeyman's) point of view, these examples illustrate the importance of questioning, checking, and rechecking drug orders and, when required, communicating with the pharmacist, nurse, or prescriber to clarify any ambiguity associated with the medication order/prescription. By doing this, you'll ensure the proper match between the drug order, the adequate dosage, and the appropriate drug dosage in order to treat the particular disease state.

014. Routes of administration

One of the most meaningful decisions a prescriber makes in regard to drug treatment is to choose the proper route of administration. The following are some of the factors that should be considered:

- The patient's condition.
- How rapidly the blood drug concentration should be established.
- The titration procedure to be followed.
- The dosing regimens that will be followed.

After all of these factors have been considered, the proper route of administration can be determined. These include the following seven options:

1. Oral.
2. Sublingual and buccal.
3. Rectal and vaginal.
4. Parenteral.
5. Topical.
6. Inhalation.

Oral

Due to its ease of administration and safety, this is the most common and acceptable route of drug administration. When the oral route is used, the drug is absorbed slowly from the gastrointestinal tract into the blood. Therefore, drug toxicity is rarely a common problem. Even in cases of deliberate intoxication, the absorption lag time by the oral route will usually allow time for drug removal by the induction of vomiting. As previously mentioned, this route can't be used in emergency situations because of its slow onset of action. In addition, the oral route shouldn't be used in comatose or sedated patients because of the danger of aspiration into the lungs. This route is also the safest route of drug administration from a toxicological, as well as from a hypersensitivity point of view.

Sublingual and buccal

Under the tongue (sublingual) or in between the cheek and gum (buccal) administration are methods of absorbing a drug rapidly into the blood and circumventing the pain of injection. This route of administration also sidesteps "first pass" liver destruction and, therefore, can be used in lower dosage than oral medications. This aids in the minimization of potential side effects.

NOTE: Antianginal medications, such as nitroglycerin and isosorbide, are examples of drugs used by this route for a rapid onset of action to relieve chest pain.

Rectal and vaginal

Rectal or vaginal administration of drugs in the form of suppositories, ointments, or solutions (douches/enemas) are used principally to treat a local disease state. Vaginal infections and hemorrhoids are examples. This method is also used for patients who can't take oral medication because of nausea and vomiting. In these cases, the rectal route can function as a means of drug administration to obtain systemic drug absorption. The following suppositories are examples:

- Prochlorperazine.
- Trimethobenzamide.
- Thiethylperazine.

The rectal route can also be utilized for cleansing purposes to prepare the lower GI (gastrointestinal) tract for surgery (e.g., Fleets[®] before a barium enema for radiological observation of the GI tract).

Parenteral

The term *parentera* refers to those drugs that are to be administered by the injectable route. The four most common parenteral routes of administration are as follows:

1. Subcutaneous.
2. Intradermal.
3. Intramuscular.
4. Intravenous.

Subcutaneous

Subcutaneous injections are made by superficial injections. Absorption of the drug into the circulation is slow and the duration of the drug's effect is long. Skin tests (mumps, candidiasis, tuberculosis) are administered subcutaneously.

Intradermal

Intradermal injections are made by deep injections into the skin.

Intramuscular

Intramuscular injections are made directly into the muscle. Because muscle is endowed with a multitude of blood vessels, the absorption into the blood is quicker than that of the subcutaneous or intradermal routes of administration. Repository (long acting) forms of a drug are frequently administered by this route (e.g., Procaine Penicillin G) as well as many hormones such as testosterone in oil.

Intravenous

This route of administration is made directly into a vein and, therefore, it has the fastest onset of action and generally the shortest duration of action. Due to this fact, drugs may require a constant administration called an IV (intravenous) infusion (e.g., Xylocaine IV infusion). Because the blood level of the drug rises rapidly when using the intravenous route of administration, it can easily overshoot its desired therapeutic endpoint, thus resulting in adverse and toxic effects. Due to this toxic liability, the IV route of drug administration is reserved for critical care situations where the benefits of immediate drug administration outweigh the risks of toxicity.

Essentially, the IV route is the most immediate in its drug effectiveness, but is also the most dangerous route of drug administration. In all cases, IV administration requires careful monitoring of dosage. To accomplish IV infusion, pumps are used to accurately control flow rates of the drug.

Topical

Skin (topical) administration of a drug is accomplished by using ointments, creams, solutions, powders, or lotions applied to the skin or mucous membranes to treat a local skin disorder. The topical route of administration is used due to the higher concentrations attained at the skin site versus those that could be achieved by any other route without the disadvantages of systemic side effects.

The condition determines the type of topical dosage form used. Because creams tend to absorb water, they're beneficial to treat pustules and oozing skin conditions. In contrast, ointments are lubricating and useful for dry, scaling conditions such as psoriasis. Creams are also vanishing and useful on exposed skin surfaces for daytime application. Conversely, ointments are greasy and unsightly and useful at nighttime.

Ophthalmic and nasal medications are also considered as topicals since they're absorbed through the mucous membrane. Again, mainly local effects are gained through these medications because there's very little systemic absorption.

Inhalation

Due to the large surface area of the lung, it's an excellent absorbing site for aerosolized drugs. The absorption rate into the blood is so rapid by this route that it's very similar to that of the intravenous route of administration. In states of shock, where the clinician is unable to find a vein because of hypotensive vascular collapse, some emergency intravenous drugs may be administered by inhalation.

(atropine). The inhalation route can also be used to treat local pulmonary or lung disorders. Some good examples of aerosol drugs with local action are beclomethasone and metaproterenol which are used to dilate the bronchiole tree in asthma.

015. Factors affecting drug activity

As you'd expect, there are a multitude of factors involved in influencing a drug's effect:

- Age.
- Body weight.
- Pregnancy.
- Time of administration.
- Circadian chronopharmacology.
- Rate of detoxification.
- Drug interactions.
- Sex and race.
- Hypersensitivity.

Age

When the term *usual dose* is used, it usually refers to a healthy adult between the ages of 15 and 60. The span of years is divided into the following patient populations:

- Pediatric.
- Middle-age.
- Geriatric.

As you'd expect, there are vast differences in the manner in which drugs are handled by the body in each population. Furthermore, each population has differences in the amounts of total body water and fat content that determine the concentration of drugs in these body compartments. The pediatric group has a relatively higher water content, and requires a higher drug dosage on a weight basis. In contrast, the geriatric group has a lower total water content, and requires a lower drug weight basis for example, digoxin.

A patient's fat content determines the storage capability of drugs that gravitate toward this body compartment. This gives many of the psychotropic drugs a long duration (e.g., chlorpromazine). The elderly are also susceptible to varying pathological states (such as arteriosclerosis, hypertension, liver or kidney function, and decreased hormonal levels). These pathological states could alter the absorption and distribution of drugs, along with compromising metabolism and excretion. This can result in drug accumulation and toxicity in the geriatric patient population.

Because newborns have immature hepatic enzyme systems, an antibiotic (such as chloramphenicol) may not be metabolized or inactivated by the liver. Because of this, the antibiotic can accumulate to produce a toxic state known as "gray baby syndrome." From this little bit of information, it's clear that in both extremes of age—pediatric and geriatric—and the extreme sensitivity of each, drugs should be administered very carefully to avoid toxicity.

NOTE: The best rule of thumb is "start low and go slow" with dose titration.

Body weight

The drug dosage to body weight ratio determines the concentration of the drug that will be achieved in the body. The usual dose of a drug (e.g., 325mg of aspirin) is designed to be administered to a 150 pound (70 kg) male, which is established as the ideal normal weight. Because many individuals fall outside this weight, dosage adjustments based on weight are made as follows:

1. An increase in dosage in the obese patient.
2. A decrease in dosage in the child or debilitated patient.

There are established dosage reduction formulas for the calculation of children's dosages and many feel there should be other formulas for the reduction of dosages in the geriatric patient.

There are accurate methods for dosing in more critical situations. These methods are based on a milligram per kilogram dosing (e.g., dosing aminophylline) and a more exact dosing procedure based on body surface (e.g., dosing cisplatin).

Pregnancy

Due to the expeditious growth and development of the fetus involving elaborate biochemical reactions, all drugs are suspect in causing teratogenic or birth defects. Consequently, drugs shouldn't be used or used only with extreme caution in pregnant women.

Time of administration

In order to achieve optimum therapeutic effect, the time of drug administration becomes very important. Adequate spacing of doses, such as every 4 to 6 hours with oral medications, ensures that there's enough time for proper absorption and optimal blood levels of the drug. In cases where more rapid absorption is desired with certain drugs, they can be given on an empty stomach or before meals (such is the case with penicillin VK). If the drug is irritating and likely to upset the patient's stomach, it may be given with food or beverage, or after meals, such is the case with ibuprofen and erythromycin.

Circadian chronopharmacology

The pharmacological response of drugs can be affected by cyclic "tides" that occur in various instances on a circadian (24-hour, rhythmic) cycle that governs body function. To receive optimal advantage of this system, cancer drugs (antineoplastics) are given early in the morning when cortisol levels are at the highest level. This provides maximum anti-inflammatory protection to the patient. Likewise, corticosteroids (such as prednisone) are dosed daily with high early-morning doses when cortisol levels are already at "high" tide. This time frame makes the most of the anti-inflammatory activity and minimizes the inhibition of the gland. Hence, dosing drugs based on biological "tides" of body chemicals may be helpful and grant favorable therapeutic outcomes for the patient.

Rate of detoxification

The major site in the body for the detoxification of many drugs is the liver. Drugs that are metabolized slowly and aren't inactivated tend to accumulate in the body. This produces toxic blood levels. A decrease in the dosage or lengthening of the dosing interval is often required to compensate for this effect. There are other drugs that may not be detoxified by the liver, but actually produce active metabolites that are responsible for sustained drug effects. An example is flurazepam.

Drug interactions

Some drugs may interfere with other drugs and chemicals when given together, thus altering their therapeutic effectiveness. Here are some examples of drugs that can alter the effect of another drug:

- Absorption into the body (e.g., digoxin and Kaopectate[®]). In this case, Kaopectate[®] decreases digoxin's gastrointestinal absorption into the blood, thereby decreasing its effectiveness in congestive heart failure. Aspirin will displace warfarin from albumin binding sites and increase its anticoagulant effect. This interaction could result in toxicity or hemorrhagia.
- Metabolism or breakdown (e.g., theophylline and cimetidine). In this case, cimetidine inhibits the hepatic metabolism of theophylline causing enhanced theophylline toxicity, which is exhibited by convulsions.

- Renal excretion (e.g., procaine penicillin G and probenecid). Probenecid diminishes the renal excretion and exit of procaine penicillin G, resulting in an increase in the blood level and also an enhancement of the procaine penicillin G's antimicrobial effectiveness.

Numerous drug interactions can be eliminated or lowered by lowering drug dosages, or by spacing or staggering the dosage of both drugs so they don't come in contact with each other in the GI tract.

Sex and race

There are definitely differences in the manner in which individuals of different sexes or races respond to drugs. Females usually tend to be hypometabolic and, consequently, accumulate drugs more readily and normally experience more side and adverse effects.

Some African-Americans have a deficiency in an enzyme called "glucose 6 phosphate dehydrogenase." This causes them to have difficulty in tolerating certain drugs (nitrofurantoin). This results in hemolytic anemia when the drug is administered.

Asians and American Indians have a defect in their enzyme systems that metabolize alcohol. This defect results in alcohol's accumulation, drunkenness, and toxicity—even at doses considered to be small. For that reason, the term "firewater" was used for alcohol consumption by the native Americans.

Hypersensitivity

We often see hypersensitivity statements on medical charts. Many times, these aren't true allergies, but are actually a drug adverse reaction. Because of this, distinguishing between the two is very important. True hypersensitivity displays as a rash, itching, hives, and ultimately as airway closure with suffocation, hypertension, and shock. This is called an anaphylactoid reaction. In addition, these effects can be preceded by gastro-intestinal upset. It's important that all symptoms are noted and evaluated. Frequently, the hypersensitive patient has a family history of asthma, hay fever, or other condition with hypersensitive etiology. These patients are frequently allergic to other chemical substances such as dyes, chocolate, or iodine. In spite of the fact that all drugs can potentially cause an allergic reaction, those that are chemically foreign to the body (such as heavy metals, penicillin, aspirin derivatives, etc.) are more likely to cause a reaction.

When patients are allergic to one chemical substance of a drug, they may also be sensitive to chemicals with similar structures. When this occurs, it's known as "cross-sensitivity to drugs." For example, cross-sensitivity can be seen with morphine and its chemical derivatives (codeine). To avoid hypersensitivity liability, it's very important that you carefully review the patient's medical history before medications are dispensed.

016. Classification of drugs

In this lesson we list the major drug classifications. This includes a listing of some of the more widely used drugs in each category. In addition, we give a few representative drugs as examples. Although the classes of drugs we discuss encompass over 90 percent of all drugs in use today, our examples aren't intended to be complete. Instead, we consider them to be a refresher. We have a more in-depth study of drug classifications and the drugs within each class when you study the different systems of the body.

Analgesics

Analgesic drugs are used to relieve pain. The type and the degree of pain determine the type of analgesic to be used. In cases of acute pain associated with a headache that's considered mild, aspirin, acetaminophen, or propoxyphene are considered adequate treatment.

In cases of more severe pain, as is the case with dental surgery or trauma, the more potent narcotic analgesics are recommended (beginning with codeine and oxycodone) than the more potent meperidine and morphine administered intermittently throughout the day. In cases of excruciating

chronic pain, like that seen in patients with arthritis and cancer, frequent administration of the potent narcotics is recommended. When the pain is so severe, as in the case of cancer, morphine can be administered by constant intravenous infusion to assure pain relief.

Anesthetics

These drugs are also used to relieve pain. They work by interfering with nerve transmission. General anesthetics accomplish this by depressing cerebral nerves that carry sensory pain signals to the brain. This produces a loss of pain and consciousness, which is beneficial during surgical procedures. General anesthetics are gases or volatile liquids administered by inhalation. Due to the flammability of many of these products, caution should be observed near electrical switches and open flames. Halothane and ether are examples of drugs in this group.

Local anesthetics may be used to relieve pain in dental extractions by local nerve blocking. More commonly, they're used topically on the skin and mucous membranes for relief of pain of minor trauma, sunburns, or painful canker sores. Some examples of local anesthetics include the following:

- Lidocaine.
- Procaine.
- Cocaine.

NOTE: Lidocaine can also be used as a cardiac membrane depressant in the treatment of cardiac arrhythmias.

Antacids

Gastric antacids are used to relieve gastric hyperacidity and the pain associated with duodenal or gastric ulcers. These agents reduce acid irritation by lowering the hydrochloric acid content of the stomach by neutralizing or buffering. This allows the ulcer site to heal. The benefits of these products are exhibited by relief of pain. Representative drugs include the following:

- Sodium bicarbonate.
- Sodium carbonate.
- Aluminum hydroxide.
- Milk of magnesia.
- Magnesium trisilicate.

Anthelmintics

These products are used to rid the body of worm infestation of the body by way of the gastrointestinal tract. The most likely source of worm infestation is contaminated food or animal saliva. When proper treatment is given, most worm infestations are curable. Drug therapy is usually limited by the toxicity of the drugs. Examples of drugs in this category include the following:

- Mebendazole.
- Diethylcarbamazine citrate.

Antianginals

Antianginals are drugs that are used to relieve the chest pain related with increased oxygen demand by the heart muscle due to physical exertion. Vasodilators, agents called *beta-adrenergic blocking agents* or *beta-blockers*, that decrease heart rate and agents that restrict the exchange of calcium through cell membranes are the primary drugs associated with this class. Both have the ability to decrease oxygen demand by the heart and subsequently relieve chest pain. Drugs in this group are vasodilators such as:

- Nitroglycerin.
- Isosorbide dinitrate.

- Isosorbide mononitrate.

The beta-adrenergic blockers are represented by the following:

- Propranolol.
- Nadolol.
- Atenolol
- Metoprolol.

The calcium channel blockers include the following:

- Diltiazem
- Verapamil
- Nifedipine

Anticholinergics

These are drugs that inhibit cholinergic nerves that are primarily responsible for gastrointestinal hypersecretions and motility. Therefore, anticholinergic drugs are used as gastrointestinal antispasmodics. Examples include the following:

- Propantheline.
- Belladonna alkaloids.
- Dicyclomine.

There are also anticholinergics that act as antispasmodics on the urinary tract. These drugs help treat urinary urgency and incontinence. Examples of these agents are as follows:

- Flavoxate.
- Oxybutinin.

Anticoagulants

These drugs inhibit the clotting mechanism in patients who have a propensity for clotting. Blood clots serve as physical barriers to blood flow when lodged in a blood vessel that supplies the brain or heart. This can result in a stroke or heart attack, seriously threatening a patient's life. Anticoagulants are used as a prophylaxis to prevent possible clotting during hemodialysis and surgery. Representative drugs include:

- Heparin.
- Warfarin.

Anticonvulsants

Drugs in this class are used to depress brain nerve firing to control convulsive seizures in epilepsy. Additionally, anticonvulsants prevent or reduce convulsions in electroshock therapy, brain damage, and ingestion of certain poisons. Examples include the following:

- Phenytoin.
- Carbamazepine.
- Diazepam.

Antidiarrheals

Liquefaction of fecal discharges or diarrhea is caused by bacteria, viruses, inflammatory processes or irritation of the bowel. It's treated with antidiarrheal agents. Antidiarrheals act by decreasing gastrointestinal activity, absorbing toxins, and replacing the bacterial flora. Representative agents include the following:

- Opium tincture (paregoric).
- Loperamide.
- Diphenoxylate.
- Kaolin-pectin mixture.

Lactobacillus acidophilus is a bacterial culture used to replace the bacterial flora of the bacterial flora of the lower gastrointestinal tract, which is often depressed or lowered during prolonged antibiotic therapy that can cause diarrhea.

Antiemetics

There are a wide variety of diseases and drugs (such as morphine and antineoplastic agents) that stimulate the vomiting center and the chemoreceptor trigger zone of the brain. The result being nausea and vomiting. Among the antiemetics are the phenothiazines. Phenothiazines function by blocking the brain centers associated with vomiting. Examples include the following:

1. Prochlorperazine.
2. Chlorpromazine.
3. Trimethobenzamide.

Some antiemetics are used before and after some treatments as an antagonist to the emetic effects of anticancer drugs. They include:

- Metoclopramide.
- Ondansetron.
- Granisteron.

Emesis (vomiting) is also associated with motion sickness. To prevent this disturbance the following are beneficial:

- Meclizine.
- Scopolamine.

Antihistamines

These drugs are used to antagonize the pathological effects of histamine that's released as a consequence of various disease states. They include the following:

- Allergy.
- Hay fever.
- Common cold.
- Asthma.
- Other conditions.

Itching, rash and reddening, and inflammation of the skin are some of the more common effects that are prevented by antihistamine agents. The following is a list of four of the more common antihistamine agents:

1. Diphenhydramine.
2. Chlorpheniramine.
3. Brompheniramine.
4. Cetirizine.

The leading side effect of antihistamines is drowsiness. Caution in operating machinery, to include driving a car, is indicated.

Within the past few years, a second generation of antihistamines has become available. These second-generation drugs are very popular because they cause little or no drowsiness. Both Loratadine and Fexofenadine differ from the first generation antihistamines in that neither of these find its way into the brain.

Antihypertensives

Hypertension (sustained elevation in blood pressure) can cause damage to body organs. In addition, it may cause secondary to vascular damage that could compromise the function of the heart, kidney, brain, and other body tissues. Consequently, the aim of treatment is to lower blood pressure in one of the following four ways:

1. By reducing vascular volume, using diuretics.
2. By relaxing blood vessels, using vasodilators.
3. By inhibiting the sympathetic nervous system that's believed to be hyperactive in this disease state, using nerve ending blocking agents.
4. By inhibiting the contraction of blood vessels through the reduction of calcium passage.

Drugs that inhibit the renal mechanism for blood elevation, using the angiotensin-converting enzyme (ACE) inhibitors may be used to lower blood pressure during long-term hypertension, where the kidney is believed to be the cause of blood pressure elevation.

Calcium plays a crucial part in the contraction of smooth muscles that control pressure on the arteries. By blocking the passage of calcium, it allows the blood vessels to relax and expand, reducing pressure.

There are many drugs in this class, among them are the following:

- Diuretics, such as hydrochlorothiazide.
- Beta-adrenergic blocking agents, such as propranolol.
- Nerve ending blockers, such as, methyldopa.
- Central nervous system blockers, such as clonidine.

Additionally, vasodilators, such as hydralazine and prozocin, the ACE inhibitors captopril and lisinopril are helpful in lowering blood pressure. Lastly, the calcium channel blockers include the following:

- Nifedipine.
- Amlodipine.
- Verapamil.
- Diltiazem.

Anti-infectives and sulfonamides

These drugs are natural or synthetic agents that can inhibit the growth (bacteriostatic) or destroy (bacteriocidal) microorganisms. Literally, there are hundreds of agents in this class. Some of these agents are used topically on the skin in the form of creams, irrigating solutions, or ointments.

Examples include the following:

- Bacitracin.
- Neomycin.
- Polymixin.

Others can be used systemically by oral, intramuscular, or intravenous administration. They include the following:

- Penicillins.
- Cephalosporins.
- Fluroquinolones.
- Tetracyclines.
- Macrolide.
- Sulfonamides.

Some of the other agents in this class are disinfectants, such as the following:

- Alcohol.
- Acetic acid.
- Boric acid.
- Iodine.
- Hydrogen peroxide.
- Merbromin.
- Thimerosal.
- Gentian violet.
- Zinc oxide.
- Hexachlorophene.
- Benzalkonium chloride.

Antineoplastics

Cellular toxins that function by destroying rapidly multiplying cells associated with cancer are called antineoplastics. In addition, they also destroy normal cells in the body—particularly those that are rapidly growing. Examples are:

- Hair cells—resulting in hair loss.
- Gastrointestinal epithelium cells—resulting in gastrointestinal ulcers.
- Bone marrow cells—resulting in blood dyscrasias.

Representative drugs include the following:

- Cisplatin.
- Vinblastine.
- Vincristine.
- Cyclophosphamide.
- Fluorouracil.

Due to antineoplastic's ability to stimulate the chemoreceptor trigger zone of the brain and the vomiting center, antiemetic drugs are often given preceding antineoplastic drug administration. They include the following:

- Prochlorperazine.
- Metoclopramide.
- Ondansetron

There are also some of the newest drugs being used for the treatment of viral infections such as Herpes Simplex, Group A influenza, and HIV (or AIDS) infection. They include the following agents:

- Acyclovir—used for Herpes Simplex infections.
- Amantadine—used for Group A influenza.
- Zidovudine (AZT)—used for HIV or AIDS infections.

Bronchodilators

Drugs that relax bronchial smooth muscle and dilate the airway that's usually constricted in pulmonary disease states are called bronchodilators or antiasthmatics. They're designed to permit normal respiratory breathing. Drugs in this class include the following:

- Albuterol.
- Epinephrine.
- Isoproterenol.
- Pseudoepinephrine.
- Theophylline.

Cardiac stimulants and depressants

Cardiac disease is a common ailment of our civilization. It's exhibited by cardiac depression and arrhythmias. In cases of cardiac depression with a slow heart rate and impulse conduction through the heart, cardiac stimulants are used. Examples are as follows:

- Epinephrine.
- Isoproterenol.

When patients have heart failure with compromised heart muscle function, drugs such as digoxin are beneficial in returning cardiac function to normal. In cases of overexcitability of the heart resulting in rhythm disturbances and rapid heart rates with depressed cardiac output of blood, the use of antiarrhythmic agents, such as the following, is indicated:

- Quinidine.
- Procainamide.
- Propranolol.

NOTE: Because these agents are so potent and often used by injection, an overdosing liability is present, with subsequent cardiac arrest or arrhythmia or even death becoming a possible outcome of treatment.

Decongestants

Drugs in the decongestant class are *vasoconstrictors*. In other words, they cause shrinking of mucous membranes, thus permitting improved air transit through the nasal and other air passages. The following drugs are among the agents in this category:

- Pseudoephedrine.
- Ephedrine.
- Phenylephrine.

Decongestants are also used in cold medication combination products.

NOTE: Because systemic vasoconstriction and elevated blood pressure are consequences of these drugs, decongestants shouldn't be used in patients with hypertension.

Digestants

These are drugs that promote digestion of food in the gastrointestinal tract in individuals, such as the elderly, who have a defect in this activity. Digestants are usually gastrointestinal replacement products for normal digestion substances that are lacking in these patients. They include the following:

- Panrelipase.
- Bile acids.
- Pancreatin.

Often times, simethicone is used along with these agents to alleviate trapped gas (flatulence) in the gastrointestinal tract—a complication of gastrointestinal disturbances.

Diuretics

One of the more frequent complications of cardiovascular disease is an abnormal accumulation of fluid in tissue spaces of the body. Commonly used diuretics act on the kidney to increase the output of urine, thereby ultimately reducing fluid accumulation (edema). Representative drugs of this class include the following:

- Hydrochlorothiazide.
- Furosemide.
- Bumetanide.
- Spironolactone.
- Acetazolamide.

Emetics

These are agents that are used to induce vomiting. Emetics are useful in eliminating poisonous substances that have been ingested. Ipecac syrup is the most popular drug used for this purpose. Ipecac syrup is taken orally and induces vomiting within a half hour. Apomorphine is another emetic less frequently used because of the pain of injection.

Hormones

Organic compounds that are normally produced *endogenously* by the endocrine glands of the body are called hormones. Oftentimes, hormones are supplemented in the form of drugs in cases of deficiency states, secondary to disease or surgery to the gland. Hormones are named by the gland that produces them and can be of natural or synthetic origin. Here are some examples:

- Pituitary hormones regulate the release of glandular hormones and are sometimes called releasing factors.
- Growth hormones regulate growth.
- Thyroid hormone regulates the activity of all body cells.
- Follicle-stimulating hormone (FSH) and luteinizing hormone (LH) control sexual growth and development.
- Corticotropin regulates corticosteroid release from the adrenal glands, which influences the ability of the body to maintain blood pressure and withstand environmental stress.
- The posterior pituitary releases a hormone called vasopressin, used to maintain blood pressure in shock.
- The hormone oxytocin is used in obstetrics to induce uterine contractility during labor.
- Pancreatic hormones include insulin, which is used to replace deficiencies seen in diabetes mellitus.
- Ovarian hormones, such as estrogens and progesterones, are used to replace a lack of these substances during menopause and ovarian dysfunction.
- The male androgens are used to prevent negative nitrogen balance in debilitating disease, to promote normal sexual function, and to treat osteoporosis and inoperable breast cancer.

- The adrenal cortical hormones, such as hydrocortisone and cortisone, are anti-inflammatory. They regulate water balance together with epinephrine and norepinephrine, and maintain blood pressure.

Hypnotics and sedatives

These are drugs that produce and maintain sleep. They're useful for the treatment of patients with sleep disturbances such as insomnia. Sometimes, they are also used in lower doses as anticonvulsants to treat epilepsy. Drugs included in this group are as follows:

- Barbiturates (such as secobarbital, pentobarbital).
- Benzodiazepine sleep-producing drugs (such as flurazepam, temazepam, and triazolam).

Continued use of these agents runs the risk of habituation with undesirable side effects from abrupt discontinuation of the drug.

Laxatives and cathartics

These drugs aid defecation in patients who are constipated or unable to empty the gastrointestinal tract of its waste materials. Laxatives and cathartics carry out this action through a wide variety of different mechanisms, to include:

- Stimulating peristalsis by irritating the gastrointestinal tract.
- Retaining water in the bowel.
- Forming bulk.
- Lubricating the bowel.
- Reducing the surface tension of fecal material.

Examples of drugs in this class include the following:

- Castor oil.
- Prunes.
- Magnesium salts.
- Phenolphthalein.
- Psyllium seed.
- Mineral oil.
- Docusate sodium.
- Senna.

Antipsychotic agents (tranquilizers)

These drugs cause a sense of detached calmness without depression of mental faculties or clouding of consciousness. The biggest use of tranquilizers is for the treatment of mental and emotional disorders. Tranquilizers can also be used for secondary problems, such as emotional distress or agitation due to surgery or cancer. Representative of this class of drugs are as follows:

- Phenothiazines (such as chlorpromazine).
- Trifluoperazine.
- Diazepam.
- Chlordiazepoxide.
- Meprobamate.

Miscellaneous drugs

Diagnostic aids, radioisotopes, and vitamins are included in miscellaneous drugs.

Diagnostic aids

These are drugs used to determine a specific disease state:

- Histamines are used for the diagnosis of achlorhydria (absence of free hydrochloric acid in the stomach).
- Barium sulfate is used orally to fluoroscopically identify gastrointestinal tract lesions of ulcers.
- Sodium diatrizoate radiopaque dye is used in patients undergoing angiography of the brain and heart and urographically for the urinary tract to visualize vascular insufficiency or aneurysms.

Radioisotopes

These are used as diagnostic aids to identify and treat particular tumors. Included in the group known as radioisotopes are:

- Radioactive isotopes of iodine.
- Phosphate.
- Gold.
- Cobalt.
- Sodium.

Vitamins

These drugs are organic catalysts that are necessary daily by the human body in small amounts for the proper functioning of certain enzyme systems that mediate chemical reactions of the cells and maintain body tissues. Included in this group of drugs are the following:

- Vitamin A.
- B vitamins (thiamine, riboflavin, niacin, pyridoxine, cyanocobalamine, folic acid, and biotin).
- Vitamin C.
- Vitamin D.
- Vitamin E.
- Vitamin K.

This has only been a brief review of pharmacology, and we'll go much further in detail later in this volume and subsequent volumes. This sampling we've presented should give you an appreciation of the many therapeutic agents present in pharmacy. It should also impress in your mind the importance of checking and double-checking the prescriber's order and the completed prescription. Be aware that with such a wide variety of chemicals available, the possibility of error increases with each passing year. The addition of new chemotherapeutic agents to the prescriber's inventory of drugs also .

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

013. The science of pharmacology

1. Find the following words pertaining to pharmacology in the word-search puzzle below:

- | | |
|------------------------|----------------------------|
| a. Adequate dosage | h. Beneficial responses |
| b. Biochemical systems | i. Checking |
| c. Circulatory system | j. Desired drug action |
| d. Dosing interval | k. Drug products |
| e. Intravenous drugs | l. Modify disease |
| f. Onset of action | m. Rational drug treatment |
| g. Symptomatology | n. Therapeutic effect |

Q	H	W	N	C	X	U	H	W	E	M	U	C	K	S	A	I	Q	N	K	W	N	J	S
B	I	O	C	H	E	M	I	C	A	L	S	Y	S	T	E	M	S	I	F	R	I	E	S
E	C	R	I	E	S	P	C	R	Z	H	P	X	F	N	V	D	L	D	A	M	D	Z	Y
N	X	T	D	C	N	K	X	M	U	C	K	S	A	I	Q	Y	G	Y	V	H	Y	U	M
E	S	H	Y	K	I	F	S	D	O	S	I	N	G	I	N	T	E	R	V	A	L	P	P
F	N	E	T	I	D	A	N	E	P	X	F	N	V	D	L	T	B	T	Q	C	T	K	T
I	I	R	O	N	Y	V	I	S	K	S	A	I	Q	Y	G	O	W	O	L	X	O	F	O
C	D	A	J	G	T	Q	C	I	R	C	U	L	A	T	O	R	Y	S	Y	S	T	E	M
I	Y	P	E	Q	O	L	D	R	F	N	V	D	L	T	B	J	R	J	G	S	J	A	A
A	T	E	Z	L	J	A	D	E	Q	U	A	T	E	D	O	S	A	G	E	N	E	V	T
L	O	U	U	G	E	G	Y	D	A	I	Q	Y	G	O	W	E	M	E	B	I	Z	Q	O
R	A	T	I	O	N	A	L	D	R	U	G	T	R	E	A	T	M	E	N	T	U	L	L
E	J	I	P	B	Z	B	T	R	V	D	L	T	B	J	R	Z	H	Z	W	D	P	G	O
S	E	C	K	W	U	D	R	U	G	P	R	O	D	U	C	T	S	U	R	Y	K	B	G
P	Z	E	F	R	P	W	O	C	Q	Y	G	O	W	E	M	U	C	P	M	T	F	W	Y
O	U	F	A	I	N	T	R	A	V	E	N	O	U	S	D	R	U	G	S	O	A	R	N
N	P	F	V	M	K	R	J	C	L	T	B	J	R	Z	H	P	X	K	H	J	V	M	I
S	K	E	Q	H	F	M	E	T	G	O	W	E	M	U	C	K	S	F	C	E	Q	H	D
E	F	C	L	C	M	O	D	I	F	Y	D	I	S	E	A	S	E	A	X	Z	L	C	Y
S	A	T	G	X	A	H	Z	O	B	J	R	Z	H	P	X	F	N	V	S	U	G	X	T
L	V	M	B	S	V	C	O	N	S	E	T	O	F	A	C	T	I	O	N	P	B	S	O

014. Routes of administration

1. What factors should be considered in regard to drug treatment and choosing the proper route of administration?
2. When the oral route of drug administration is used, how and where is the drug absorbed?
3. What are two methods of drug administration that allow for rapid drug absorption into the blood, without the pain of an injection?
4. What method of drug administration (not injectable) can be used in patients with nausea and vomiting to obtain systemic drug absorption?
5. To what does the term *parenteral* refer?
6. Which method of drug administration is considered to have the fastest onset of action and generally the shortest duration of action?
7. Why is the topical route of administration used?
8. Give an example of an emergency intravenous drug that can be administered by inhalation to patients in a state of shock, where the clinician is unable to find a vein because of hypotensive vascular collapse?

015. Factors affecting drug activity

1. To what types of patients does the term “usual dose” refer to?
2. What are two of the dosage adjustments (based on weight) used for patients who fall outside the normal weight-dosing standard?
3. Why are all drugs given to pregnant women suspect in causing teratogenic or birth defects?

4. How can oral drugs be given to patients when a more rapid drug absorption is desired?
5. What's the circadian cycle?
6. What happens to drugs that are metabolized slowly?
7. What are some methods of eliminating or lowering drug interactions?
8. What happens to Afro-American patients having "glucose 6 phosphate dehydrogenase" deficiency when they're given certain drugs, such as nitrofurantion?
9. In what manner does a "true hypersensitivity" to a drug display itself?

016. Classification of drugs

1. What determines the type of analgesic that's prescribed for a patient?
2. How do general anesthetics relieve pain?
3. What local anesthetic can also be used as a cardiac membrane depressant in the treatment of cardiac arrhythmia's?
4. How do gastric antacids reduce acid irritation?
5. What class of drugs is used to rid the body of worm infestation that has gained entry into the body by way of the gastrointestinal tract?
6. List three vasodilators (drugs)?
7. What are anticholinergic drugs used for?

8. What class of drugs are heparin and warfarin?
9. Give some examples of an anticonvulsant drug.
10. What's the mode of action of antidiarrheals?
11. What drugs are used before and after treatment as an antagonist to the emetic effects of anticancer drugs?
12. What's the leading side effect of antihistamines?
13. What's the aim of antihypertensive drug therapy? How is this accomplished?
14. Give some examples of disinfectants.
15. What are antineoplastic drugs?
16. What class of drugs are used for the treatment of viral infections, such as Herpes Simplex, Group A influenza, and HIV (or AIDS) infection?
17. What's another term used to describe bronchodilators?
18. When are antiarrhythmic agents used?
19. What class of drug is pseudoephedrine?
20. What class of drug promotes digestion of food in the gastrointestinal tract in individuals, such as the elderly, who have a defect in this activity?

21. In what class of drug is hydrochlorothiazide?
22. What's the most popular drug used for eliminating poisonous substances that have been ingested?
23. How are hormones named?
24. What classes of drugs are useful in the treatment of patients with insomnia?
25. What are laxatives and cathartics?
26. What's the biggest use of antipsychotic agents?
27. What class of drugs is used to determine a specific disease state?

3-2. Basic Biopharmaceutics

In this section, you'll learn some new pharmaceutical terminology. First, though, you'll begin with an introduction to basic biopharmaceutics. Then, you'll learn about the process of drug absorption, drug disposition, elementary pharmacokinetics, and therapeutic drug monitoring.

017. Introduction to basic biopharmaceutics

Pharmaceutics is a term used to describe the area of pharmaceutical sciences that deals with the chemical, physical, and physiological properties of drugs and dosage forms, and drug-delivery systems. This guarantees the following six drug-delivery factors:

1. In the proper amounts.
2. To the place where the drug is needed.
3. With minimal side effects.
4. With minimal inconvenience.
5. With maximum compliance.
6. With maximum reliability.

As a general rule, pharmaceutics incorporates the principles involved in the following:

- Physical phenomena.
- Biopharmaceutics.
- Pharmacokinetics.
- Manufacturing.

- Compounding.
- Dispensing of medicine.

Biopharmaceutics

A major branch of pharmaceuticals is termed *Biopharmaceutics*. Biopharmaceutics concerns itself with the relationship between the physicochemical properties of a drug in a dosage form and the pharmacologic, toxicologic, or clinical responses observed after drug administration. It studies the relationship of the biological properties of drug absorption, drug distribution, metabolism, and excretion to the drug dosage form.

NOTE: Biopharmaceutics, as a science, helps explain the effects of patient variability by gender, age, body area, genetic considerations, and the disease state. It's essential for all health workers who deal with drug therapy and patient care to gain some knowledge of the principles of basic biopharmaceutics.

Pharmacokinetics

Pharmacokinetics is defined as a mathematical description of these processes as they relate to the time course in the body. Additionally, pharmacokinetics relates these processes to the intensity and time course of therapeutic and adverse effects of drug administration.

Clinical pharmacokinetics

Clinical pharmacokinetics is described as the discipline that deals with the application of pharmacokinetics to the safe and effective therapeutic management of individual patients. Therefore, clinical pharmacokinetics studies the mathematical relationship of drug absorption, drug distribution, metabolism, and excretion to safe and effective drug therapy during patient care.

Bioavailability

This term is used to indicate the rate and relative amount of administered drug that reaches the circulatory system intact. Bioavailability is a term frequently used in connection with the evaluation of drug-dosage format, along with the following five terms:

1. Chemical equivalent.
2. Biological equivalents.
3. Therapeutic equivalents.
4. Pharmaceutical alternates.
5. Therapeutic alternates.

Chemical equivalent

This is multiple source drug products that contain essentially identical amounts of the identical active ingredient, in identical dosage forms, and that meet existing physical-chemical standards in the official compendium.

Biological equivalents

They are chemical equivalents that, when administered in the same amounts, will provide the same biological or physiological availability, as measured by blood levels, urine levels, or other suitable means.

Therapeutic equivalents

They are chemical equivalents that, when administered in the same amounts, will provide the same therapeutic effect as measured by the control of a symptom or disease.

Pharmaceutical alternates

They are drug products that contain the same therapeutic active ingredient and strength, but differ in the salt, ester, or dosage form, and are administered by the same route.

Therapeutic alternates

They are drug products containing different therapeutic moieties but the same pharmacological and/or therapeutic class that can be expected to have similar therapeutic effects when administered to patients in therapeutically equivalent doses.

Dosage forms and the time courses

In the past, the most significant parameters concerning drug therapy were class, activity, and dose-response relationships. With the advent of biopharmaceutics, the importance of dosage forms and the time courses became noticed. Precisely, the relationship of drug concentration to response became the focus in how these factors are affected by the route of administration and the properties of the drug and dosage form. The appropriate concentration of a drug at a receptor site and its mediation by distribution and elimination also play an important role.

018. Drug absorption

The most common route of administration for drugs is the oral route. The gastrointestinal tract plays a major role on the effects of oral drugs in the body—whether they're tablets, capsules, or some other dosage form. Drugs can also be administered by nonoral routes, such as the parenteral (injection) route, suppository, use of transdermal patches, or other methods. Drug absorption is involved in all these routes of administration, except those administered intravenously or, in rare cases, intra-arterially. In these instances, drugs are considered to be administered directly into the circulation. In doing so, the drug doesn't undergo an absorption step. Therefore, for all other cases, there's a drug absorption step that may play a significant role in patient response to drug therapy.

Biological considerations

Drug absorption involves the passage of drug molecules through biological membranes. Membranes are composed of two thin layers and honeycombed with very small pores or holes. You'll look at the following three biological considerations:

1. Passive transport.
2. Active transport.
3. Gastrointestinal (GI) tract.

Passive transport

The transport of drugs through biological membranes is understood to be the result of *passive diffusion*, which is the movement of drug molecules from an area of higher concentration to one of lower concentration.

Active transport

In some peculiar cases, a drug is perceived to be transported by *active transport*, which involves the use of energy. This means it would be possible to go “against” the usual concentration gradient. These cases can be viewed as unusual and won't be referred to in the future.

Gastrointestinal (GI) tract

The GI tract is extremely important when you're dealing with oral dosage forms. The major sites of drug dissolution and absorption are the stomach, small intestine, and large intestine. Under normal conditions, the stomach maintains a potential hydrogen (pH) of 1 to 3. This low pH is maintained by the production of hydrochloric acid (among other constituents in the stomach) resulting in dosage forms experiencing an acidic environment when first taken orally. This fact can be applied to formulate delayed- or sustained-release formulations or to protect certain drugs that may be sensitive to acid.

Small intestine

The small intestine is about 275 cm long. Approximately 20 to 25 cm of this belongs to the duodenum. The duodenum is recognized as one of the most active areas of drug absorption. The pH environment of the small intestine is approximately 4 to 7, depending on locale. Beginning at the stomach, the pH is approximately 4. The pH increases to approximately 7 in the large intestine.

The small intestine has small projections that are normal parts of its inner lining structure. These projections are villi and impart a relatively large surface area to the small intestine. It's the large surface area that gives the small intestine its ability to absorb the drug better than other areas of the GI tract.

Large intestine

The large intestine is frequently referred to as the bowel. It has these three areas:

1. Ascending.
2. Transverse.
3. Descending.

These areas, generally, have a pH ranging from 7 to 7.5.

The large intestine is usually responsible for the absorption of water, although some drug absorption can occur. This is best illustrated by the blood levels achieved from drugs administered as suppositories or retention enemas, such as acetaminophen.

The fluid components of the GI tract are varied, depending on exactly what location is studied. In the stomach, hydrochloric acid, mucin, mucus, pepsin, and ingested substances form a mixture. After a certain period of time (known as the gastric emptying time), this mixture begins to pass to the small intestine in stages. There are many factors that can affect this gastric emptying time:

- Drugs.
- Volume.
- Type of meal.
- Body position.
- Viscosity of contents.
- Emotional state of patient.

As a general rule, most of the factors reduce or slow the rate of gastric emptying. One notable exception is the use of the drugs metoclopramide and cisapride, which increase the rate of gastric emptying.

With reference to body position, the rate of emptying is reduced in patients lying on their left side when compared to their right side. In addition, aggressive or stressful emotion states increase stomach contractions and emptying rate. Stomach contractions and emptying may be reduced in patients experiencing depression.

There are some additional components added in the small intestine. For example, enzymes are contributed from pancreatic secretions, including pancreatic lipase. In addition, bile salts contribute an effect and are thought to be physiologic surface active agents. As such, they help to wet and dissolve hydrophobic drugs and improve absorption of poorly soluble drugs.

NOTE: Generally speaking, the longer time a drug is retained in the small intestine, the better the extent of absorption.

The GI tract is considered to be an exceedingly vascularized area. Twenty-eight percent of cardiac output is received via the circulatory system serving the intestines and total GI tract. Due to the fact that drugs are absorbed into this general circulation, there's no drug buildup in this area. This

process—in which drugs are immediately removed—is referred to as “maintaining sink conditions”; that is, no increase in drug concentration occurs in blood when compared to the site of absorption within the intestine.

Physicochemical parameters

The fundamental physical and chemical properties of a drug can influence the passive absorption of that drug. The physical properties include the following four factors:

1. Solubility.
2. Particle size.
3. Crystal form.
4. Dissociation constant.

The chemical factors consist of the following two:

1. Drug lipophilicity.
2. Stability.

These parameters and their importance are a measure of the nature of the membranes of the GI tract. Drug molecule penetration into the membranes is a partitioning effect. If the membrane is thought to be lipid in nature and the contents of the GI tract are aqueous, then the molecules penetrate cells in the same relative order as their oil-to-water partition coefficient. Major exceptions include the very small molecules that penetrate faster than expected. This is due to holes or pores that allow the passage of small hydrophilic drug molecules through the membrane.

Most drug molecules are either weak acids or weak bases and are usually ionized to some extent. This is dependent on the fluid in which they're dissolved. Drug molecules are usually thought to pass through membranes in the unionized state; therefore, the pH of the medium or fluid may play a role in drug absorption. The penetration of a drug that's a weak base would be enhanced by alkalization (addition of base) because a greater fraction of the drug will be present in the unionized form. One item of interest is that many times the unionized form is the least soluble. Consequently, a balance must be achieved if a solution of a drug is to be prepared.

019. Drug disposition

After drug absorption, the drug is carried by the blood to various sites. They include the tissues and organs in the body. Drug delivery occurs simultaneously to all tissues, including those organs of elimination.

Disposition

Disposition is a term used when no distinction should be made between elimination and distribution, or if it's too difficult to discern. Drug disposition may be defined as all the processes that occur subsequently to the absorption of a drug.

Components of disposition

The components of disposition are distribution and elimination.

Distribution

Distribution is the process of reversible transfer of a drug to and from the site of measurement, usually by the blood. Any drug that leaves the site of measurement and doesn't return has undergone elimination.

Drug distribution to body tissues occurs at various rates and to various extents. To what rate and extent is determined by how well each area is perfused with blood, by how well the drug is bound to plasma proteins and tissue components, and by the permeability of tissue membranes to the drug. The rate of distribution of the drug between blood and tissue can be limited by either perfusion or

diffusion. Perfusion rate limitation occurs when the tissue membranes present no barrier to distribution. This happens when both small and highly lipophilic drugs diffuse across all tissue membranes, and with most drugs diffusing across such loosely knit membranes as muscle capillary walls.

In instances where distribution is restricted or limited by diffusion of the drug, it usually increases for polar drugs that diffuse across tightly knit lipid membranes. This type of diffusion rate limitation occurs when considering drug distribution to cerebral spinal fluid.

Distribution is also a very important concept when relating the amount of drug in the body to its measurement in biological fluids. The concentration of drug in the plasma, with time following administration of a single dose, is dependent on the rate and extent of distribution to the tissues and how rapidly the drug is eliminated. The majority of drugs have distribution occurring more rapidly than elimination. The concentration achieved is an outcome of the dose and extent of distribution to the tissues.

The extent of distribution may be determined by relating the concentration obtained to a known amount of the drug in the body. There's nothing more to this than comparing an amount of drug distributed in some volume (*an apparent volume*) and is referred to as the "apparent volume of distribution." This volume is usually measured as the volume of plasma at the drug concentration required to account for all the drug in the body.

Elimination

Elimination is the irreversible loss of a drug from the site of measurement. There are two common processes by which elimination occurs:

1. Metabolism.
2. Excretion.

Metabolism

Metabolism is the conversion of one chemical species to another. In essence, the process of metabolism serves three purposes:

1. Supplies energy for body functions.
2. Breaks down ingested compounds or synthesizes more complex compounds.
3. Performs conversion or biotransformation of molecules to more polar, ionized structures that can be excreted more easily.

Drug metabolism refers to the chemical biotransformation in the body. Although there are many exceptions, this often leads to a drug species that has little or no pharmacologic activity.

The liver is the principal site of drug metabolism in the body. Secondary sites include the kidney, muscle tissue, and gut wall. There are times when a significant loss of drug occurs from the site of oral absorption through the gut wall and liver, with metabolism occurring the first time through the body prior to the drug reaching its site of action. This loss of drug is known as "first pass effect." Drugs that have shown to be examples of this process include propranolol and morphine, along with other analgesics and antidepressants.

NOTE: Oxidation, reduction, hydrolysis, and conjugation (a pairing or joining) are the most common reaction encountered when studying biotransformation.

Excretion

Excretion is the irreversible loss of the chemically unchanged drug. The liver and kidney are the two main organs of elimination. The kidney is the primary site for excretion of unchanged drugs. On the other hand, the liver is the usual organ for drug metabolism.

NOTE: The kidney, as well as other organs, can also play an important metabolic role for some drugs.

The liver may also excrete any unchanged drug into the bile. Once the unchanged drug is excreted into the bile, the drug may be reabsorbed from the gall bladder or intestinal tract. This process is known as *enterohepatic cycling*. If all the drug is reabsorbed by this cycling mechanism, biliary excretion isn't a route of elimination. But, the cycling would then be considered a component of distribution.

Biliary excretion does become a route of elimination when a portion of the drug that's excreted from the biliary tree fails to be reabsorbed. This drug would most likely be excreted in the feces.

Drugs may experience final elimination or excretion from the systemic circulation by different pathways other than the renal and bile routes. Two other common routes include saliva (penicillin) and milk (anticoagulants).

NOTE: Many drugs may distribute to milk; hence, lactating (breast-feeding) mothers should take extra precautions when taking *ANY* drug regimen.

The renal pathway, by way of the urine, is the most important route of excretion. The major unit responsible for filtering blood is the nephron. Both unchanged drug and metabolites are filtered by glomerular filtration and excreted from the body.

020. Elementary pharmacokinetics

Pharmacokinetics furnishes a mathematical description of the biological processes of drug absorption, distribution, metabolism, and excretion, as they relate to drug time course in the body. The techniques most often used involve analysis of data from blood samples or biological fluids (urine specimens, etc.) and some basic assumptions. These assumptions require that the body behave as one compartment or a series of compartments and are commonly referred to as model-type behavior. While meticulous mathematics are often required to analyze complete sets of data for model-dependent drug regimens, such analyses are often easy to follow for graphical interpretation and representation. Unfortunately, this type of model application doesn't apply to all drugs.

In cases where drugs tend to distribute slowly, the model-dependent analysis tends to become complicated with multicompartmental characteristics. To overcome this problem, a more recent technique was introduced. This technique is called noncompartmental pharmacokinetic analysis. This analysis provides for calculating absorption, distribution, and elimination parameters based on statistical moments. Any further discussion of noncompartmental pharmacokinetic analysis is beyond the scope of this lesson.

Parameters

Certain important pharmacokinetic parameters can be calculated from analyses of data from such simple model-dependent drug behavior. These parameters become very significant when you're trying to accomplish the following:

- Understand new drugs.
- Relating similar drugs.
- Designing drug regimens.
- Modifying dosing for patient-specific conditions.
- Guarding against toxicity, while at the same time being able to derive maximum benefits from drug therapy.

Bioavailability

Studies of bioavailability determine the relative amount of an administered dose of a drug that reaches the general circulation and the rate at which this occurs. When drugs are administered by other than the intravenous route and act systemically, their potency will probably be related to the amount of drug the dosage form delivers to the blood. If the pharmacologic effects of the drug are directly and

instantaneously related to its plasma concentration, the rate of absorption will be important because it will determine the height of the peak of the blood concentration curve, and the time at which the peak occurs. Therefore, it's safe to say that bioavailability indicates the rate of absorption and levels of concentration of a drug in the bloodstream needed to produce a therapeutic effect.

The concepts involved in studying the bioavailability of a drug can relate to three major factors:

1. The rate and extent of release of the drug from the dosage form and its subsequent absorption.
2. The first pass effect, wherein only a small fraction of the drug reaches the general circulation intact.
3. Consideration of the combined processes of plasma protein binding; tissue protein binding; drug distribution, metabolism, and excretion.

Bioavailability differences and variability can happen for a given drug between dosage units, from lot to lot in the manufacturing process, and in this same dosage form from multiple manufacturers. Using measurements of drug concentrations in the blood as a function of time is the most common procedure for establishing drug bioavailability.

Bioequivalency

Bioequivalency is the comparison of bioavailability of one dosage form to another and where appropriate, the rates of absorption and levels of concentration of two doses in the blood. You may draw comparisons of drugs from one manufacturer to another. When there's a recognized manufacturer for a particular drug, called the *innovator*, it's common to compare others to the parameters of the innovator product. The Food and Drug Administration has issued guidelines for such bioequivalency studies—especially in support of Abbreviated New Drug Applications.

NOTE: Because injectable products are directly introduced into the blood, and because other injectable products are designed for introduction into various body tissues, we've confined our consideration of bioavailability and bioequivalency to oral solid products.

021. Therapeutic drug monitoring

One of the most important inpatient services offered by many hospitals today is therapeutic drug monitoring. This service consists of a combination of measuring serum drug concentrations coupled with clinical pharmacokinetics. This type of service program has come about because of the need to carefully monitor drug therapy in those patients with specific ailments, such as diseases of the drug elimination organs, and the use of drugs with severe toxicity problems. Because of the advent of the pocket calculator and computer-literate personnel, dosage regimen adjustment can be done on an individual basis with adjustments for a wide variety of problems or patient-specific variables.

Therapeutic drug monitoring has proved to be an extremely cost-effective tool in many institutional settings. Various types of patients have benefited from such programs, including pediatric and geriatric patients. Through the prudent use of this service, some institutions have documented a reduction in morbidity.

Serum drug concentrations are most advantageous when a correlation has been established between the actual serum level and some known pharmacologic effect. This is best demonstrated when the intensity and duration of effect are directly related to serum concentration. In such cases, serum concentration adjustments produce changes that allow for proper dosage adjustment for individual patients. This is especially useful when therapeutic ranges have been developed for drug therapy and dose-concentration relationships and factors can be manipulated to provide enhanced drug treatment and patient care outcomes.

Therapeutic drug monitoring is most valuable for those drugs with a narrow therapeutic serum concentration range and when response is predictable from such monitoring. Additionally, the proper choice of sampling time for monitoring is important for interpretation. Generally, it's better to sample at trough times (just before the next dose) to assess serum concentrations for evaluation of therapeutic

efficacy. Doing so will show if the minimum drug level is falling within the prescribed limits for therapeutic efficacy. If the trough levels are sub-therapeutic, the clinician may give smaller doses more frequently while maintaining the same dose over a daily regimen. Doing so should reduce the inter-dose fluctuation, but for drugs with very narrow therapeutic ranges, some knowledge of both peak and trough levels may be desirable. It's important to remember that steady-state levels for constant dosing won't be achieved for four to five drug half-lives. This factor must be kept in mind when sampling prior to reach steady-state.

Currently there are about a dozen drugs routinely monitored in programs. These drugs include the following:

- Theophylline.
- Aminoglycoside antibiotics.
- Phenytoin.
- Methotrexate.
- Digoxin.
- Tricyclic antidepressants.
- Lithium.

This number of drugs will continue to increase as the value of therapeutic drug monitoring becomes more recognized. Additionally, and of equal importance, will be the implementation of therapeutic drug-monitoring programs in ambulatory care settings, extended care facilities, and home health care programs.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

017. Introduction to basic biopharmaceutics

1. What term is used to describe the area of pharmaceutical sciences that deals with the chemical, physical, and physiological properties of drugs and dosage forms and drug-delivery systems?
2. What are biopharmaceutics?
3. What term is used to describe the mathematical description of biopharmaceutical processes as they relate to drug time course in the body?
4. Define chemical equivalent.
5. What factors are of primary consideration when considering drug distribution?

018. Drug absorption

1. In what routes of drug administration do drugs not undergo an absorption step?
2. What's passive diffusion?
3. What are the major sites of drug dissolution and absorption?
4. What factors can effect gastric emptying time?
5. What drug increases the rate of gastric emptying?
6. What are some of the physical properties of a drug that can influence passive absorption of a drug?

019. Drug disposition

1. Define drug disposition.
2. What are the two components of drug disposition?
3. Define metabolism.
4. What are the three purposes of metabolism?
5. How is the rate and extent of drug distribution determined?
6. What two methods can limit the rate of distribution of a drug, between blood and tissue?
7. What's the "apparent volume of distribution?"

8. What are the two main organs of drug elimination?
9. What's the most important route of excretion?
10. What is first pass effect?

020. Elementary pharmacokinetics

1. What type of calculations do noncompartmental pharmacokinetic analysis provide?
2. What studies determine the relative amount of an administered dose of a drug that reaches the general circulation and the rate at which this occurs?
3. What is bioequivalency?
4. What three major factors are involved in studying the bioavailability of an orally administered drug?

021. Therapeutic drug monitoring

1. What are the components of therapeutic drug monitoring?
2. When are serum drug concentrations most advantageous in therapeutic drug monitoring?
4. For what types of drugs are therapeutic drug monitoring most valuable?

[illegible]

1. The patient's condition, how rapidly the blood drug concentration should be established, the titration procedure to be followed, and the dosing regimens that will be followed.
2. The drug is absorbed slowly from the gastrointestinal tract into the blood.
3. Sublingual and buccal.
4. Rectal.
5. Those drugs that are to be administered by the injectable route. Intradermal, subcutaneous, intramuscular, and intravenous are the most common parenteral routes of administration.
6. Intravenous.
7. It's used due to the higher concentrations attained at the skin site versus those that could be achieved by any other route without the disadvantages of systemic side effects.
8. Atropine.

1. It usually refers to a healthy adult between the ages of 15 and 60.
2. An increase in dosage in obese patients and a decrease in dosage for children or debilitated patients.
3. Because the expeditious growth and development of the fetus involves elaborate biochemical reactions.
4. They can be given on an empty stomach or before meals.

5. It's 24-hour, rhythmic cycle that governs body functions.
6. They aren't inactivated and tend to accumulate in the body.
7. By lowering drug dosages or by spacing or staggering the dosage of both drugs so they don't come in contact with each other in the GI tract.
8. They experience hemolytic anemia when the drug is administered.
9. Rash, itching, hives, and ultimately as airway closure with suffocation, hypertension, and shock.

016

1. The type and degree of pain the patient is experiencing.
2. They depress the cerebral nerves that carry sensory pain signals to the brain. This produces a loss of pain and consciousness.
3. Lidocaine.
4. By lowering the hydrochloric acid content of the stomach by neutralizing or buffering.
5. Anthelmintics.
6. (1) Nitroglycerin.
(2) Isosorbide dinitrate.
(3) Isosorbide mononitrate.
7. Gastrointestinal antispasmodics.
8. Anticoagulants.
9. Phenytoin, carbamazepine, diazepam.
10. They act by decreasing gastrointestinal activity, absorbing toxins, and replacing the bacterial flora.
11. Metoclopramide and ondansetron.
12. Drowsiness.
13. To lower blood pressure by reducing vascular volume, using diuretics. By relaxing blood vessels, using vasodilators; by inhibiting the sympathetic nervous system that's believed to be hyperactive in this disease state, using nerve ending blocking agents; drugs that inhibit the renal mechanism for blood elevation, using the angiotensin-converting enzyme (ACE) inhibitors. (May be used to lower blood pressure during long-term hypertension, where the kidney is believed to be the cause of blood pressure elevation.)
14. Alcohol, acetic acid, boric acid, iodine, hydrogen peroxide, merbromin, thimerosal, gentian violet, zinc oxide, hexachlorophene, and benzalkonium chloride.
15. Cellular toxins that function by destroying rapidly multiplying cells associated with cancer. In addition, they also destroy normal cells in the body—particularly, those that are rapidly growing, such as hair cells, resulting in hair loss; gastrointestinal epithelium cells, resulting in gastrointestinal ulcers; and bone marrow cells, resulting in blood dyscrasias.
16. Antivirals.
17. Antiasthmatics.
18. In cases of overexcitability of the heart resulting in rhythm disturbances and rapid heart rates with depressed cardiac output of blood.
19. Decongestant.
20. Digestants.
21. Diuretics.
22. Ipecac syrup.
23. By the gland that produces them.
24. Hypnotics and sedatives.
25. Drugs that aid defecation in patients who are constipated or unable to empty the gastrointestinal tract of its waste materials.
26. For the treatment of mental and emotional disorders.
27. Diagnostic aids.

017

1. Pharmaceutics.
2. A major branch of pharmaceutics that concerns itself with the relationship between the physicochemical properties of a drug in a dosage form and the pharmacologic, toxicologic, or clinical responses observed after drug administration. It studies the relationship of the biological properties of drug absorption, drug distribution, metabolism, and excretion to the drug dosage form.
3. Pharmacokinetics.
4. Those multiple source drug products that contain essentially identical amounts of the identical active ingredient, in identical dosage forms, and meet existing physical-chemical standards in the official compendium.
5. Onset and intensity of response.

018

1. Intravenous and intra-arterial.
2. The movement of drug molecules from an area of higher concentration to one of lower concentration.
3. The stomach, small intestine, and large intestine.
4. Volume, type of meal, drugs, body position, viscosity of contents, and emotional state of the patient.
5. Metoclopramide.
6. Solubility, particle size, crystal form, and dissociation constant.

019

1. All the processes that occur subsequently to the absorption of a drug.
2. Distribution and elimination.
3. The conversion of one chemical species to another, while *excretion* is the irreversible loss of the chemically unchanged drug.
4. It (1) supplies energy for body functions, (2) breaks down ingested compounds or synthesizes more complex compounds, and (3) performs conversion or biotransformation of molecules to more polar, ionized structures that can be excreted more easily.
5. It's determined by how well each area is perfused with blood, by how well the drug is bound to plasma proteins and to tissue components, and by the permeability of tissue membranes to the drug.
6. Perfusion or diffusion.
7. The volume of plasma at the drug concentration required to account for all the drug in the body.
8. Liver and kidney.
9. The renal pathway by way of the urine.
10. When a significant loss of drug occurs from the site of oral absorption through the gut wall and liver, with metabolism occurring the first time through the body prior to the drug reaching its site of action.

020

1. Calculations of absorption, distribution, and elimination parameters based on statistical moments.
2. Studies of bioavailability.
3. It's the comparison of bioavailability of one dosage form to another, and where appropriate, the rates of absorption and levels of concentration of two doses in the blood.
4. (1) The rate and extent of release of the drug from the dosage form and its subsequent absorption, (2) the first pass effect, wherein only a small fraction of the drug reaches the general circulation intact, and (3) consideration of the combined processes of plasma protein binding; tissue protein binding; drug distribution, metabolism, and excretion.

021

1. A combination of measuring serum drug concentrations coupled with clinical pharmacokinetics.
2. When a correlation has been established between the actual serum level and some known pharmacologic effect.

3. Drugs with a narrow therapeutic serum concentration range and when response is predictable from such monitoring.

Do the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter.

33. (013) The science that deals with the nature of drugs and their interactions with other drugs, foods, or the body is called
- pharmacology.
 - pharmacognacy.
 - biopharmaceutics.
 - pharmacokinetics.
34. (013) Which product administration is preferable when a drug is to be given to an unconscious patient?
- Oral.
 - Rectal.
 - Topical.
 - Injectable.
35. (014) Which is *not* a factor to be considered when you are choosing the proper route of drug administration?
- The patient's condition.
 - Drug side-effects that could occur.
 - The dosing regime that will be followed.
 - How rapidly the blood drug concentration should be established.
36. (014) Which medication bypasses "first pass" liver destruction?
- Acetaminophen tablets.
 - Amoxicillin suspension.
 - Prochlorperazine suppositories.
 - Nitroglycerin sublingual tablets.
37. (015) The drug storage capability of any given body compartment is determined by the patient's
- age.
 - sex.
 - fat content.
 - water content.
38. (015) When you are determining the *usual* dose of a drug, what is the established "ideal normal weight?"
- 100 pounds.
 - 125 pounds.
 - 150 pounds.
 - 175 pounds.

39. (015) A patient who is allergic to one chemical substance of a drug and is also sensitive to chemicals with similar structures is said to be
- hyperallergic.
 - cross-allergic.
 - hypometabolic.
 - cross-sensitive.
40. (016) What class of drugs is used to inhibit nerves that are *primarily* responsible for gastrosectetions and motility?
- Anticholinergics.
 - Antidiarrheals.
 - Antiemetics.
 - Antacids.
41. (016) What class of drugs has the ability to *decrease* oxygen demand by the heart?
- Anticholinergics.
 - Anticoagulants.
 - Antihelmintics.
 - Antianginals.
42. (016) What class of drugs are cellular toxins that function by destroying rapidly multiplying cells associated with cancer?
- Antivirals.
 - Antiemetics.
 - Antineoplastics.
 - Antihistamines.
43. (016) What term best describes organic compounds that are *normally* produced endogenously by the endocrine glands?
- Digestants.
 - Histamines.
 - Hormones.
 - Vitamins.
44. (017) What term *best* identifies the branch of pharmaceutics that concerns itself with the relationship between the physiochemical properties of a drug in a dosage form and the pharmacologic, toxicologic, or clinical responses observed after the drug has been administered?
- Pharmacognacy.
 - Biopharmaceutics
 - Pharmacotherapeutics.
 - Clinical pharmacokinetics.
45. (017) Which type of equivalent describes drugs that contain essentially identical amounts of the identical active ingredient, in identical dosage forms?
- Generic.
 - Chemical.
 - Biological.
 - Therapeutic.
46. (018) What is the most *commonly* used route of drug administration?
- Oral.
 - Topical.
 - Inhalation.
 - Parenteral.

-
-
47. (018) Which is *not* a factor in influencing gastric emptying time?
- a. Drugs.
 - b. Body position.
 - c. Gastric blood flow.
 - d. Viscosity of contents.
48. (019) The conversion of one chemical species to another describes what portion of drug disposition?
- a. Diffusion.
 - b. Excretion.
 - c. Elimination.
 - d. Metabolism.
49. (019) The *principle* site of drug metabolism in the body is the
- a. liver.
 - b. kidney.
 - c. stomach.
 - d. small intestine.
50. (020) What element of pharmaceuticals furnishes a mathematical description of the biological processes of drug absorption, distribution, metabolism, and excretion as they relate to drug time course in the body?
- a. Pharmacotherapeutics.
 - b. Pharmacokinetics.
 - c. Biopharmaceutics.
 - d. Pharmacognacy.
51. (020) What term *best* describes the relative amount of a drug that reaches the general circulation and the rate at which this occurs?
- a. Bioavailability.
 - b. Biopharmaceutics.
 - c. Biological equivalency.
 - d. Physiochemical parameters.
52. (021) Therapeutic drug monitoring is *most* valuable for those drugs with a
- a. narrow therapeutic serum concentration range and when response is predictable from such monitoring.
 - b. broad therapeutic serum concentration range and when response is predictable from such monitoring.
 - c. narrow therapeutic serum concentration range and when response is unpredictable from such monitoring.
 - d. broad therapeutic serum concentration range and when response is unpredictable from such monitoring.
53. (021) What is the *best* time to sample serum concentrations for therapeutic monitoring?
- a. At trough times.
 - b. In the morning.
 - c. In the evening.
 - d. At peak times.

Student Notes

Unit 4. Introduction to the Human Body

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BEFORE you look very deeply into disease states, the organs they effect, and how drug therapy can help, take a look into how the body is organized. In essence, you'll be delving into *anatomy*, which is the science of the structure of organisms. This will help you understand future lessons. First, you'll study the five levels of organization within the human body. You'll begin with the body as a whole and continue with the different levels of organization. Once you learn the systemic level, a brief description of each system is given. You'll then study the part body cavities and functions play in the practice of phamacology. During our lessons, you'll look at specific body cavities and homeostasis. You'll also have a lesson covering some generalizations about how the body functions.

You'll conclude the unit with discussions covering disease in the human body. The subjects include disease terminology, diagnosis, treatment, and prevention of disease, infectious disease, microorganisms, helminths, infection control, chemotherapy, and pathogenic identification by the laboratory

4–1. The Body as a Whole

You'll start this lesson with an overview. We do this because we feel it is important you see how the body is structured into different levels so that it may function as a whole. This knowledge is vital because it shows you how all of the parts are organized and how they logically fit together and function effectively.

022. Levels of organization

Figure 4–1 shows the different levels of organization that influence body structure and function. As you can see, the levels are as follows:

- Chemical.
- Cellular.
- Tissue.
- Organ.
- System.

When they're combined, these structural levels equal the body as a whole.

Chemical level

The organization of the human body begins at the chemical level. In fact, it's the organization of chemical components that separates living from nonliving material. The complex and unique relationships that exist between atoms and molecules in living material form protoplasm, which is the essential material of all cells. The type of chemical organization required for life and maintained in the protoplasm requires the expenditure of energy. Unless proper relationships between chemical elements are maintained, a living person can soon become a lifeless corpse.

In addition to its specific organization, certain characteristics of protoplasm characterize it as a living substance. These characteristics of life include the following:

- Metabolism (a generalized term used to describe such physical and chemical processes as nutrition, digestion, secretion, absorption, respiration, and excretion).
- Irritability.
- Conductivity.
- Contractility.
- Growth.
- Reproduction.

Of all these properties, reproduction is considered the most fundamental characteristic of a living thing.

Cellular level

Ultimately, the characteristics of life result from a hierarchy of structure and function. This process begins with the organization of atoms and molecules. If viewed from the perspective of an anatomist, the most important function of the chemical level of organization is to supply the basic building blocks for next higher level of body structure—the cellular level.

Cells are the smallest and most numerous structural units that possess and exhibit the basic characteristics of living matter. Each cell is surrounded by a membrane and characterized by a single nucleus surrounded by protoplasm (cytoplasm), which contains numerous structures required for specialized activity. All cells have certain common features, but they specialize or differentiate in order to perform unique functions. For example, fat cells are structurally modified to allow the storage of lipid material. Some other examples of structurally and functionally specialized cells are the muscle, bone, nerve, and blood cells.

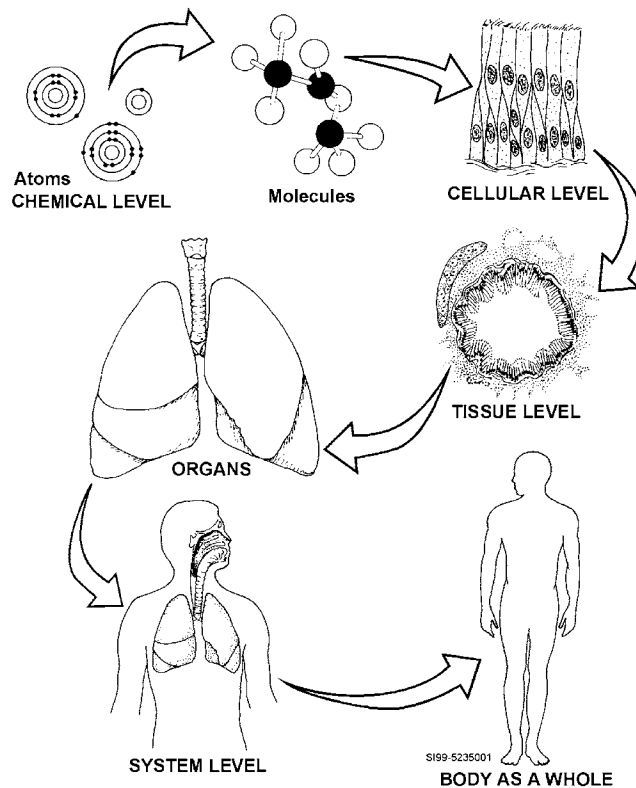


Figure 4-1. Structural levels of organization in the body.

Tissue level

The tissue level is the next higher level of organization beyond the cell. Tissues symbolize another step in the hierarchical organization of living matter. By definition, a tissue is an organization of many similar cells that are specialized to perform a certain function. The four major tissue types are:

1. Epithelial.
2. Connective.
3. Muscle.
4. Nervous.

When you consider the complex nature of the human body, this is a surprisingly short list of major tissues; however, each of the four major tissue types can be subdivided into a number of specialized subtypes. Collectively, the body tissues are able to meet all of the structural and functional needs of the body.

Organ level

Organs are more complex units than tissues. They're an organization of several different types of tissues so arranged that collectively they can perform a special function. Each lung is an example of organization at the organ level. Muscles and specialized connective tissues form the numerous tubes that convey air. Epithelial tissues line the microscopic air sacs and nervous tissues permit control of airflow and muscular contraction.

Tissues rarely exist in isolation. Instead, joined together, they form organs that represent distinct but functionally complex operational units. Each organ can be identified by the pattern of tissues that form it, and each organ has its own unique shape, size, appearance, and placement in the body. Some examples of organs are as follows:

- Lungs.
- Heart.
- Brain.
- Kidneys.
- Liver.

System level

The most complex of the component units of the body is the system. The system level of organization encompasses varying numbers and types of organs so arranged that collectively they can perform complex functions for the body. There are 10 major systems in the human body:

1. Integumentary system.
2. Skeletal system.
3. Muscular system.
4. Nervous system.
5. Endocrine system.
6. Circulatory system; includes the cardiovascular and lymphatic systems.
7. Respiratory system.
8. Digestive system.
9. Urinary system.
10. Reproductive system.

Integumentary system

The integumentary system (or skin) is shown in figure 4–2. This system is crucial to survival itself. It includes both layers of the skin and its appendages: hair, nails, and specialized glands. The skin's primary function is protection. In this role, the skin does these three things:

1. Protects underlying tissue against invasion by harmful microorganisms.
2. Bars entry of most chemicals.
3. Minimizes mechanical injury of underlying structures.

The skin also helps to regulate body temperature, synthesizes important chemicals and hormones, and functions as a sophisticated sense organ.

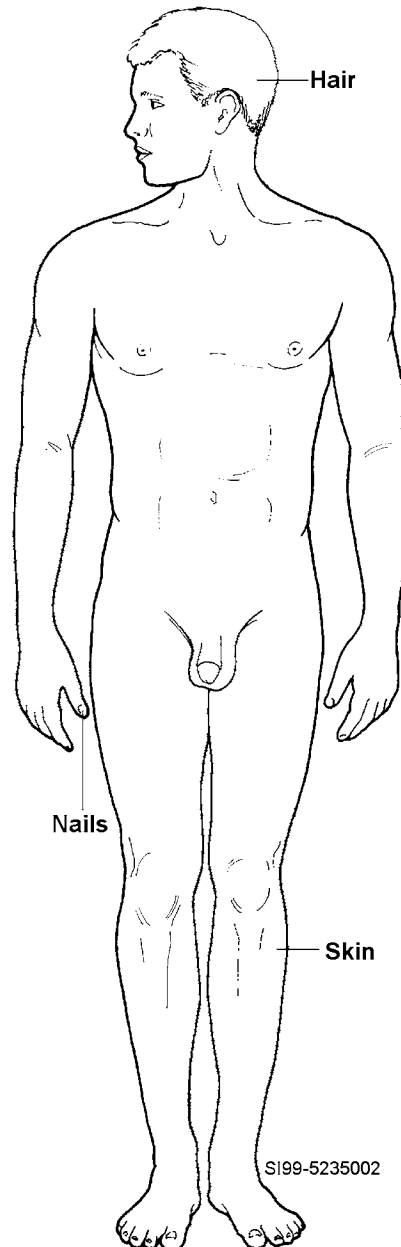
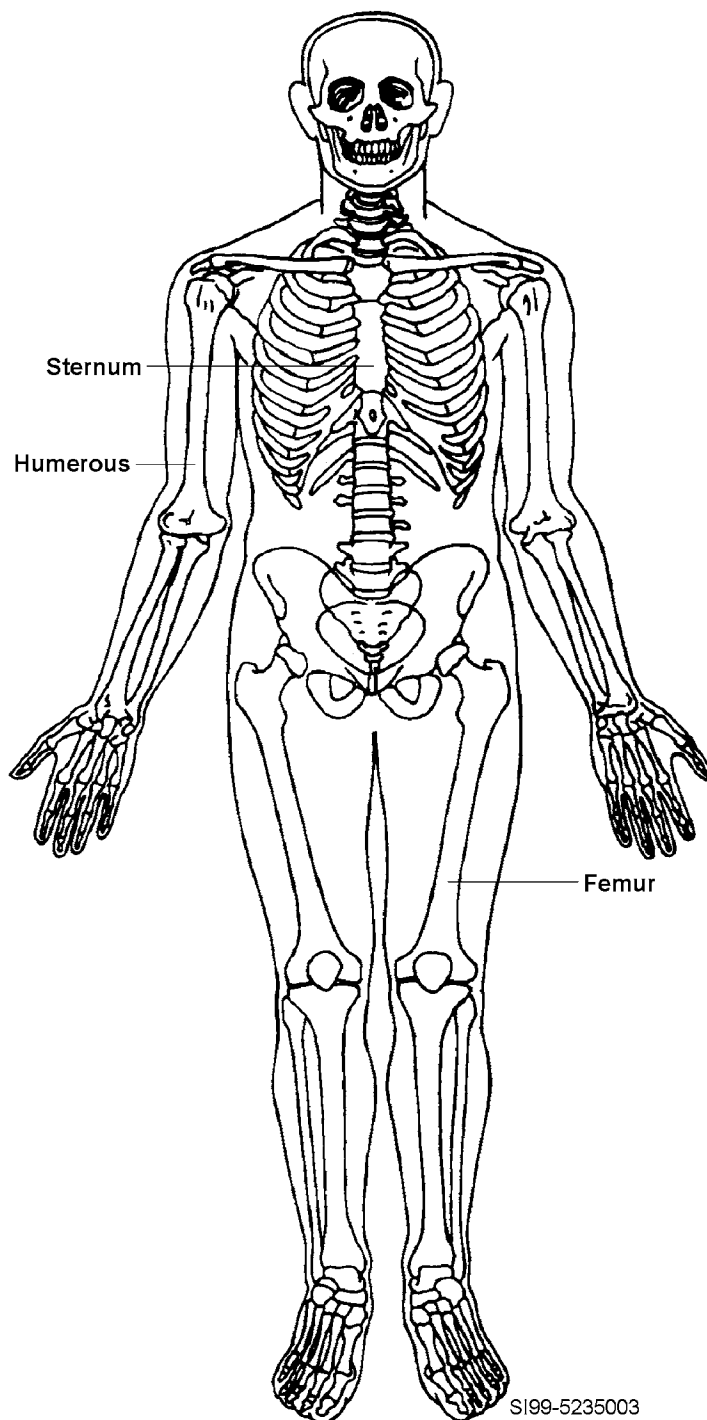


Figure 4–2. Integumentary system.

Skeletal system

The skeletal system is shown in figure 4-3. It's composed of the bones and related tissues, such as cartilage and ligaments. Collectively, these parts form the skeletal system, which provides the body with a rigid framework for support and protection. The skeletal system, through joints or articulations, also makes movement possible. Additionally, the bones also serve as reservoirs for mineral storage and function in hemopoiesis or blood cell formation.



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Figure 4-3. Skeletal system.

Muscular system

The muscular system is shown in figure 4-4. It's made up of the individual muscles themselves. The system contains the following parts:

- Smooth or involuntary muscles.
- Voluntary or skeletal muscles.
- Cardiac muscle of the heart.

Muscles produce movement (or maintain posture). In addition, they're also responsible for generating the heat required for maintaining the body's constant core temperature.

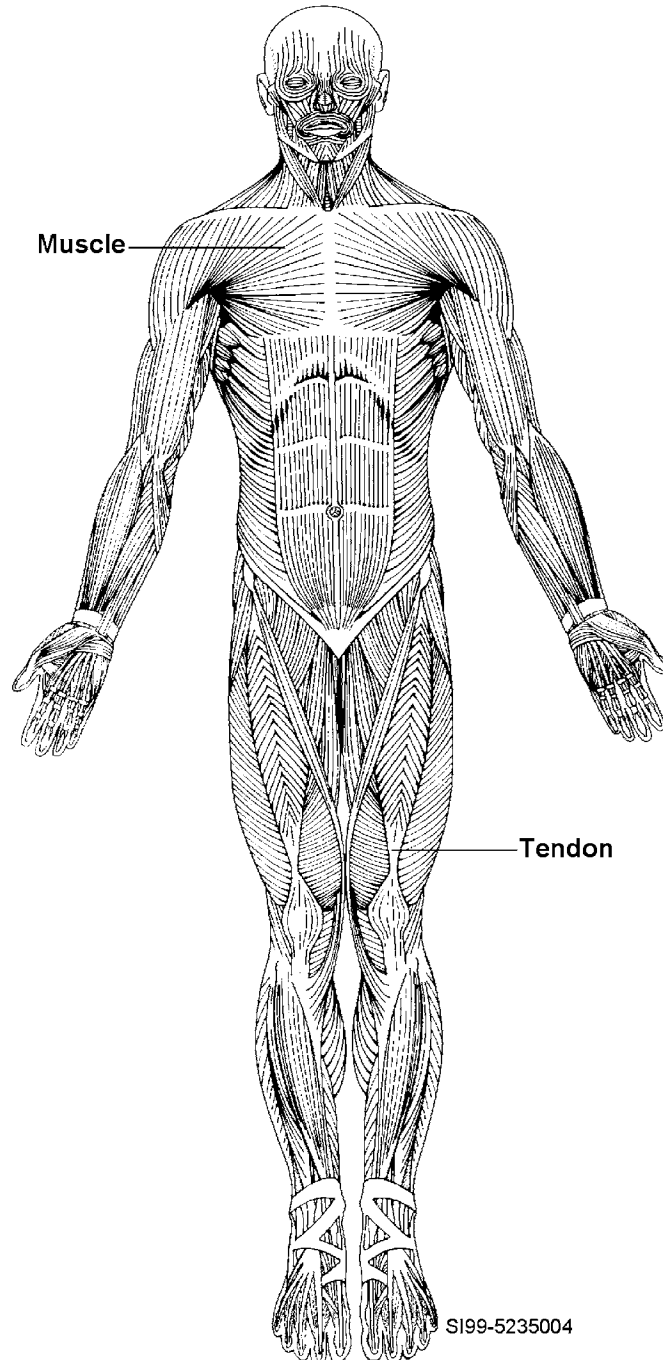


Figure 4-4. Muscular system.

Nervous system

The organs of the nervous system are shown in figure 4–5. They include the following:

- Brain.
- Spinal cord.
- Nerves.

Communication, integration, and control of body functions are the primary functions of this complex system. These functions are achieved through the generation, transmission, integration, and recognition of specialized nerve impulses. Nerve impulses allow the rapid and accurate control of diverse body functions. Elements of the nervous system also serve to recognize certain stimuli—such as heat, light, pressure, or temperature—that affect the body. Nerve impulses are then generated to communicate this information to the brain where it's analyzed and appropriate action is initiated. Some other types of nerve impulses cause glands to secrete and muscles to contract.

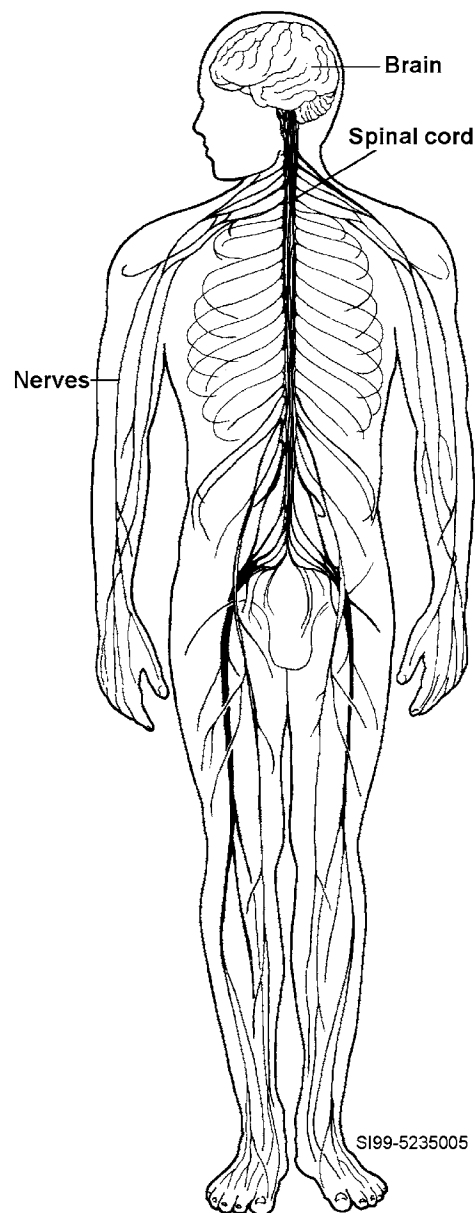


Figure 4–5. Nervous system.

Endocrine system

The organs of the endocrine system are shown in figure 4–6. This system is made up of specialized glands that secrete chemicals known as hormones directly into the blood. All of the following glands function as endocrine glands:

- Pituitary.
- Pineal gland.
- Hypothalamus.
- Thyroid.
- Parathyroids.
- Adrenals.
- Pancreas.
- Ovaries.
- Testes.
- Thymus.
- Placenta..

The organs of the endocrine system, also called ductless glands, perform the same general functions as the nervous system; that is, communication, integration, and control. Fast-traveling nerve impulses provide rapid, yet brief control in the nervous system. In contrast, the endocrine system provides a slower but longer-lasting control by secretion of hormones. Target organs, descriptively, are organs that are acted on and respond in some way to a particular hormone. The hormones are the main regulators of metabolism, growth and development, reproduction, and many other body activities. They also play an important role in such areas as fluid and electrolyte balance, acid-base balance, and energy metabolism.

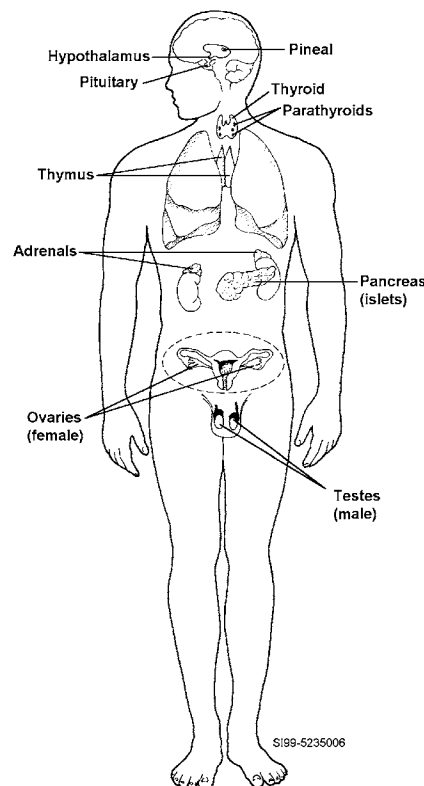


Figure 4–6. Endocrine system.

Circulatory system

There are two components of the circulatory system (fig. 4-7), the cardiovascular and lymphatic systems.

Cardiovascular system

Figure 4-7 shows the cardiovascular system. As you can see, the following elements make up this system:

- Heart and arteries.
- Veins.
- Capillaries.

The primary function of the cardiovascular system is transportation of substances that are critical to life. This includes the movement of oxygen and carbon dioxide, nutrients, hormones, and other important substances on a continuing basis.

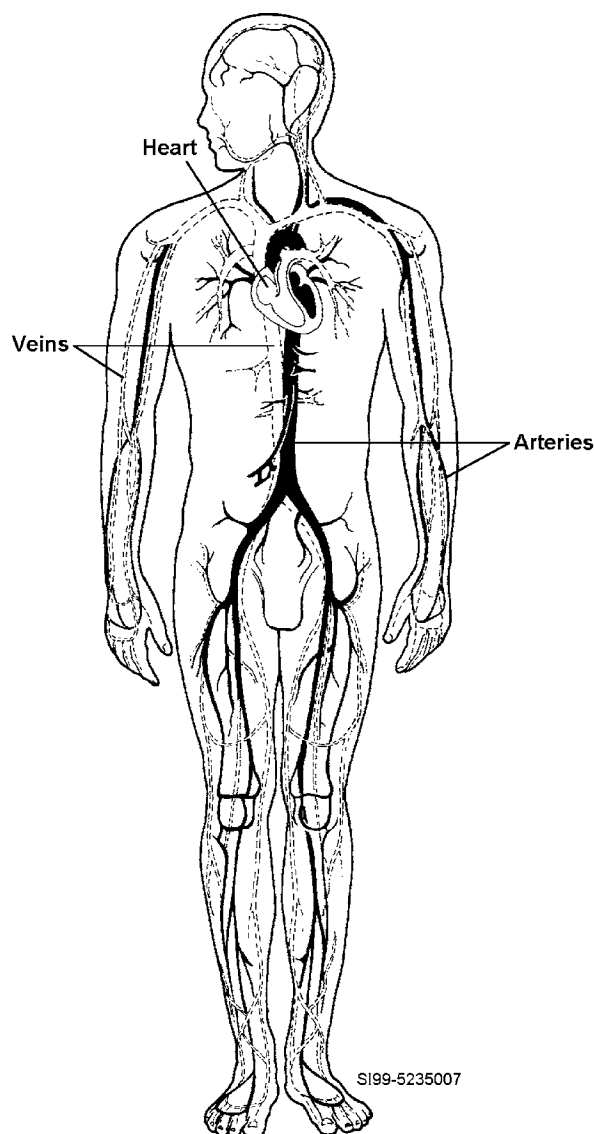


Figure 4-7. Cardiovascular system.

Lymphatic system

Figure 4–8 shows the elements of the lymphatic system. The elements of this part of the circulatory system include the following:

- Lymph.
- Lymphatic vessels.
- Lymph nodes.
- Specialized lymphatic organs, such as the thymus and spleen.

Two functions of the lymphatic system are:

1. The movement of fluids and certain large molecules from the tissue spaces surrounding the cells.
2. Movement of fat-related nutrients from the digestive tract back to the blood.

This system also plays a part in the overall functioning of the immune system.

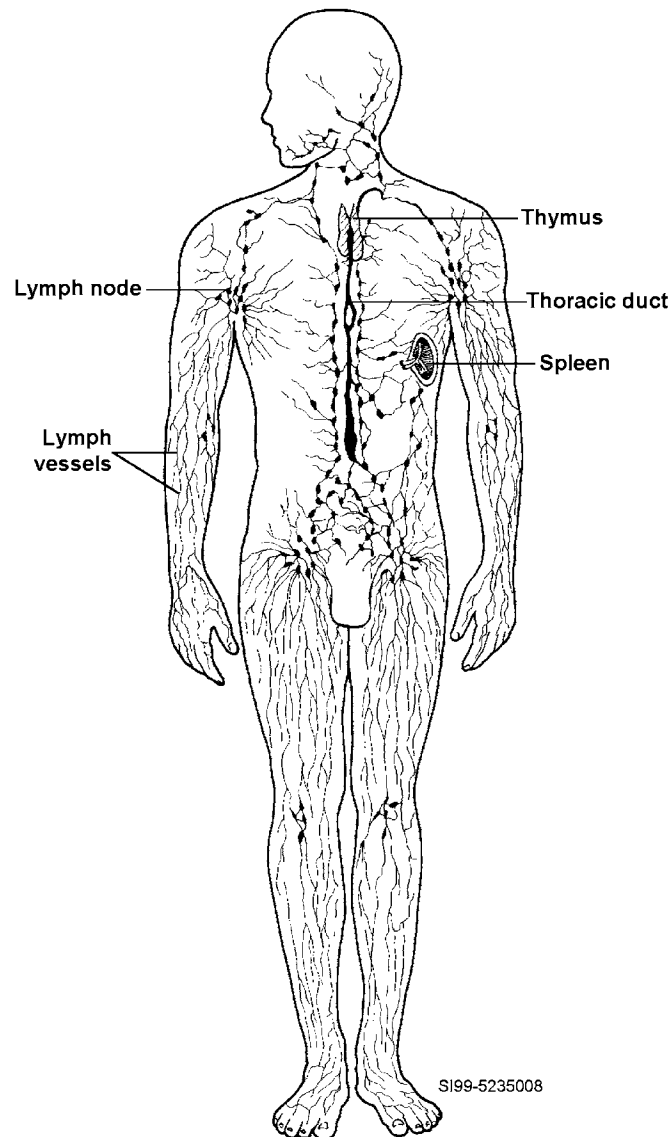


Figure 4–8. Lymphatic system.

Respiratory system

An illustration of the respiratory system is shown in figure 4-9. As you can see, the organs of this system are as follows:

- Nose.
- Pharynx.
- Larynx.
- Trachea.
- Bronchi.
- Lungs.

Collectively, these organs permit the movement of air into the tiny, thin-walled sacs of the lungs, known as the *alveoli*. Oxygen from the air is exchanged for the waste product carbon dioxide in the alveoli. The carbon dioxide is then carried to the lungs by the blood so it can be eliminated from the body.

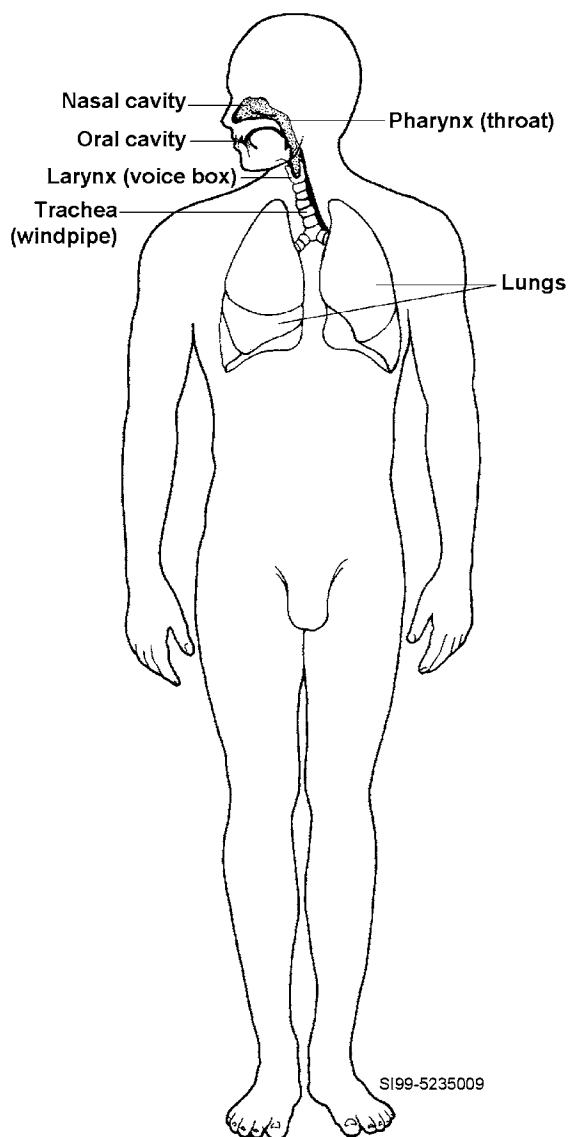


Figure 4-9. Respiratory system.

Digestive system

The digestive system is shown in figure 4-10. The main organs of this system include the following:

- Mouth.
- Pharynx (throat).
- Esophagus.
- Stomach.
- Small intestine.
- Large intestine.
- Rectum.
- Anal canal.

The digestive system also has accessory organs:

- Teeth.
- Tongue.
- Salivary glands.
- Liver.
- Gallbladder.
- Pancreas.

The main organs of the digestive tract form a tube that's open at both ends. This tube is known as the gastrointestinal, or GI, tract. Food entering the tract is digested, nutrients are absorbed, and the undigested residue is eliminated from the body as waste material.

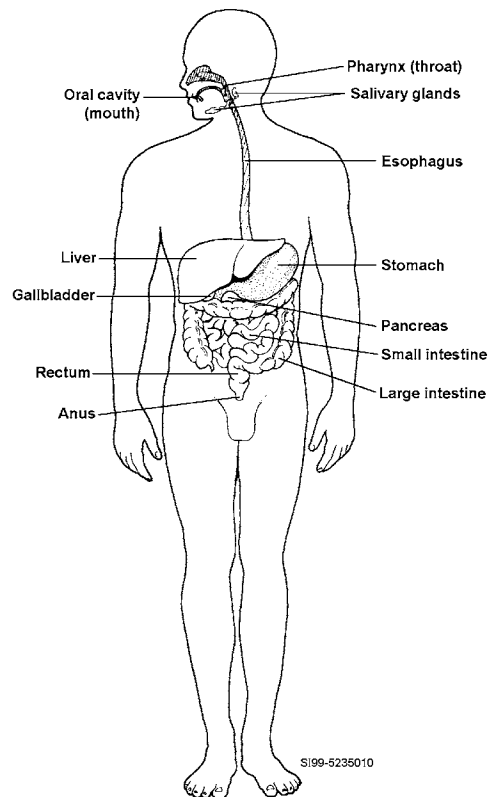


Figure 4-10. Digestive system.

Urinary system

The urinary system is shown in figure 4–11. The organs of this system are as follows:

- Two kidneys.
- Bladder.
- Urethra..

The main function of the kidneys is to clear or clean the blood of the many waste products that are continually produced by metabolism of foodstuffs in the body cells. They also play an important role in the maintenance of electrolyte, water, and acid-base balance in the body.

Urine is the waste product produced by the kidneys. Once urine is produced, it flows out of the kidneys, through the two ureters, and into the urinary bladder where it's stored. It then passes from the bladder to the outside of the body through the urethra.

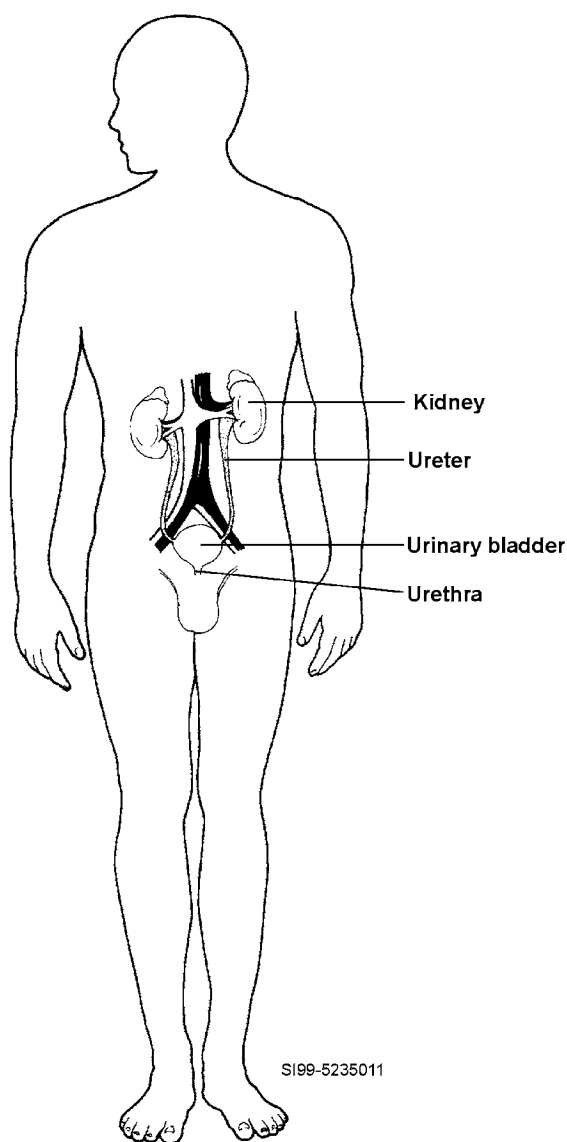


Figure 4–11. Urinary system.

Reproductive system

Survival of the species is ensured by the proper functioning of the reproductive system. In addition, production of hormones that permit development of the sexual characteristics occur as a result of normal reproductive system activity. Of course, our species include both male and females—each with their own reproductive system.

Male reproductive system

The reproductive system of the male is shown in figure 4-12. The system includes the following elements:

- Gonads (testes), which produce the sex cells or sperm.
- Genital ducts.
- Accessory glands.
- Supporting structures.

The genital ducts include the following:

- Epididymis.
- Vas deferens.
- Ejaculatory ducts.
- Urethra..

The accessory glands consist of the following:

- Seminal vesicles.
- Prostate.
- Bulbourethral (cowper's) glands.

The supporting structures include the following:

- Scrotum.
- Penis.
- Spermatic cords.

Collectively, these structures function to produce, transfer, and, ultimately, introduce sperm into the female reproductive tract where fertilization can occur.

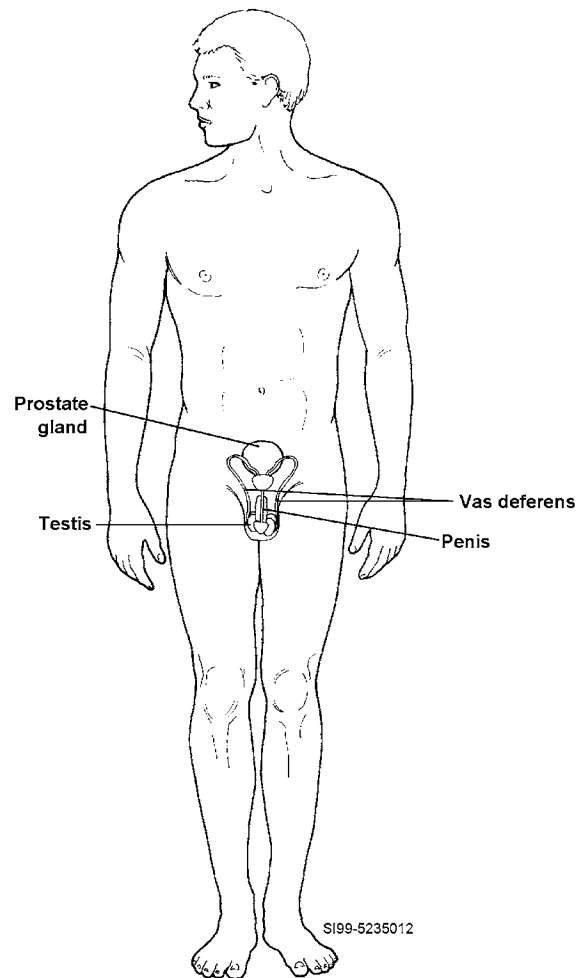


Figure 4-12. Male reproductive system.

Female reproductive system

The female reproductive system is shown in figure 4–13. The accessory organs of the female reproductive system include the following:

- Ovaries, which are the female gonads.
- Uterus.
- Uterine (fallopian) tubes.
- Vagina.
- Vulva.

The female reproductive organs are intended to produce the sex cells or ova, receive the male sex cells, permit fertilization and transfer of the sex cells to the uterus, and allow for development, nourishment, and birth of the offspring.

NOTE: The mammary glands (breasts) are also classified as external accessory sex organs in the female.

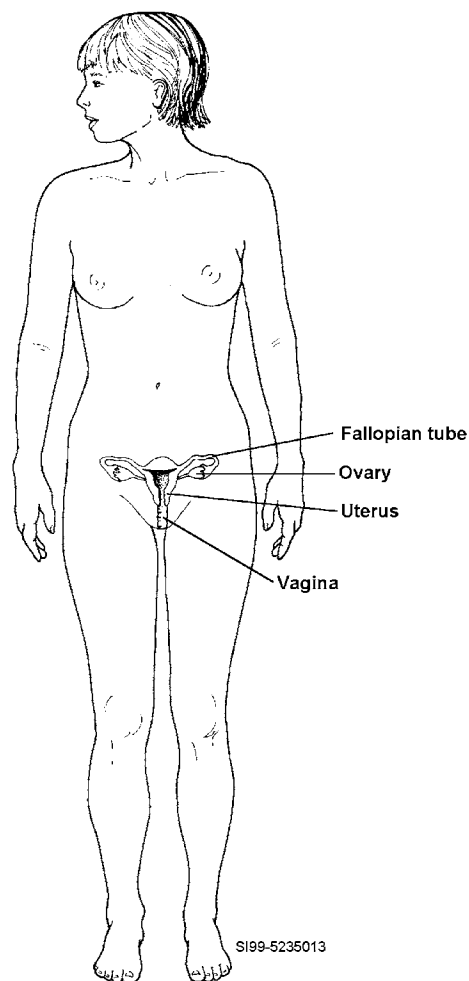


Figure 4–13. Female reproductive system.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

022. Levels of organization

1. List the six characteristics of life.
2. From an anatomical point of view, what's the most important function of the chemical level of organization in the human body?
3. Define tissue.
4. What are the four major tissue types?

5. What are organs?
6. What's the most complex of the component units of the body?
7. What's the primary function of the integumentary system?
8. What are the three primary functions of the nervous system?
9. What are the two components of the circulatory system?
10. List two functions of the lymphatic system.
11. What's the main function of the kidneys?

4-2. Body Cavities and Functions

In our overview of the body, you learned the different levels of organization. As the organization became greater, different processes took place. The spaces inside of the body where these functions occur are called cavities. You probably hated that word when you were a young child, but we promise you we won't be doing any dental drilling in our discussion of cavities. You'll start with a discussion of the various body cavities, followed by a discussion of homeostasis, which is a key word in modern physiology. This is followed by a discussion of some generalizations about body function. You'll conclude the section by studying the interaction of structure and function. Let's get started; you have a lot of information to cover.

023. Body cavities

Contrary to its external appearance, the body isn't a solid structure; instead, it contains two major cavities:

1. Ventral (belly).
2. Dorsal (back).

These two cavities are further subdivided and contain compact, well-ordered arrangements of internal organs. Figure 4-14 shows the location and outlines of these body cavities.

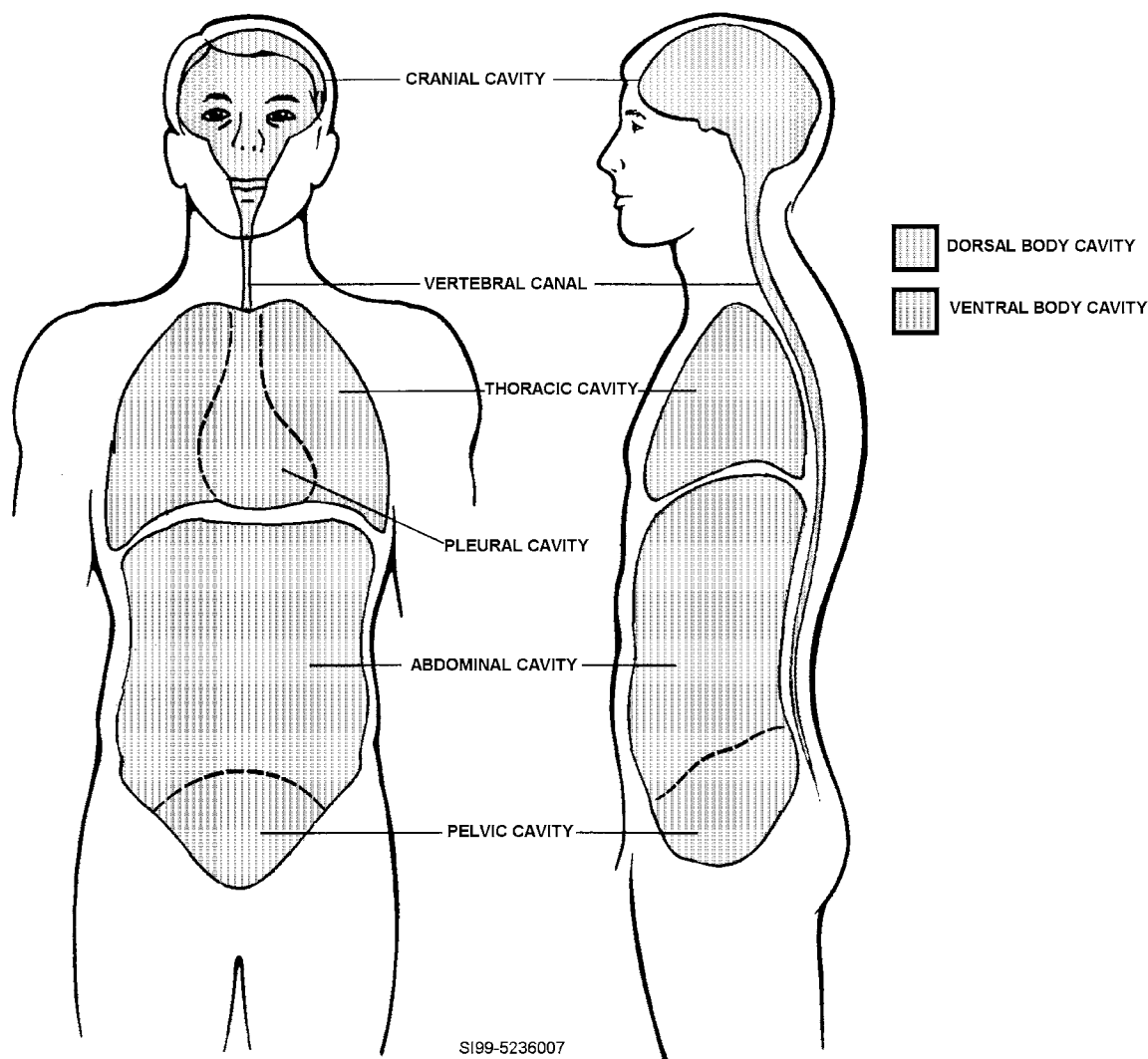


Figure 4-14. Location and subdivisions of the major body cavities.

Ventral cavity

The thoracic or chest cavity and the abdominopelvic cavity are in the ventral cavity.

Thoracic cavity

The thoracic cavity consists of a right and a left pleural cavity. In addition, there's a midportion called the mediastinum. The mediastinum is completely separated from the right (where the right lung lies) and left (where the left lung lies) pleural sacs by a wall of fibrous tissue. Because of this, the only organs in the thoracic cavity that aren't located in the mediastinum are the lungs.

The following eight organs are located in the mediastinum:

1. Heart (enclosed in its pericardial sac).
2. Trachea and right and left bronchi.
3. Esophagus.
4. Thymus.
5. Various blood vessels (e.g., thoracic aorta, superior vena cava).
6. Thoracic duct and other lymphatic vessels.

7. Various lymph nodes.
8. Nerves (such as the phrenic and vagus).

Abdominopelvic cavity

The abdominopelvic cavity has an upper portion, called the abdominal cavity, and a lower portion, called the pelvic cavity.

Abdominal cavity

The abdominal cavity contains the following eight organs:

1. Liver.
2. Gallbladder.
3. Stomach.
4. Pancreas.
5. Intestines.
6. Spleen.
7. Kidneys.
8. Ureters.

Pelvic cavity

The following three organs lie in the pelvic cavity:

1. Bladder.
2. Certain reproductive organs (uterus, uterine tubes and ovaries in the female; prostate gland, seminal vesicles, and part of the vas deferens in the male).
3. Part of the large intestine (the sigmoid colon and rectum).

Dorsal cavity

The dorsal cavity contains the two cavities:

1. Cranial.
2. Spinal.

Cranial cavity

The brain is housed in the cranial cavity, which is located in the skull.

Spinal cavity

The spinal cord is housed in the *spinal cavity* and lies in the spinal column.

NOTE: Regardless of its location or function, every organ undergoes change over the years. Before maturity (young adulthood), organs develop and grow. As their function decreases after maturity, the organs (in general) *atrophy* or waste away.

024. Homeostasis

More than a century ago, a French physiologist named Claude Bernard (1813 to 1878) made a remarkable observation. He noticed that the only time body cells survived in a healthy condition was when the temperature, pressure, and chemical composition of their fluid environment remained relatively constant. He used the term *milieu interne* (internal environment) to describe the environment of cells.

Later, a famous American physiologist named Walter B. Cannon (1871 to 1945) suggested the name homeostasis for the relatively constant states maintained by the body. The word homeostasis comes from these two Greek words:

1. *Homoios*—meaning “the same.”
2. *Stasis*—meaning “standing.”

The literal meaning of *homeostasis* is “standing or staying the same.” Cannon emphasized, however, that homeostasis doesn’t mean something that’s set and immobile and that stays exactly the same all the time. In Cannon’s own words, *homeostasis* means “a condition that may vary, but which is relatively constant.” For example, homeostasis of blood temperature means that it remains relatively constant at about 37° C, but may vary slightly above or below this temperature. In another example, homeostasis of blood glucose concentration means a relative constancy between 80 and 100 mg of glucose per 100 mL of blood.

In a brief manner, *homeostasis* may be defined as “relative constancy of the extracellular fluid.” Although we use the term extracellular fluid, there are actually two fluids that make up this fluid:

1. Interstitial fluid.
2. Blood plasma.

NOTE: The microscopic spaces between cells are filled with interstitial fluid and, consequently, is also referred to as intercellular fluid.

Homeostatic mechanisms

Homeostatic mechanisms are devices that maintain or restore homeostasis. These mechanisms involve the functioning of virtually all of the body’s organs and systems. Consequently, the major theme of physiology is homeostatic mechanisms. As an example, here is a brief description of a homeostatic mechanism that acts to restore homeostasis of blood carbon dioxide concentration. This certain mechanism is turned on, or activated, by a slight increase in blood carbon dioxide concentration above its homeostatic level. This increase stimulates certain nerve cells in the brain, causing them to send out more nerve impulses to certain breathing muscles. This is followed by faster breathing, and more carbon dioxide leaves the blood for the expired air. Therefore, blood carbon dioxide concentration decreases back toward its homeostatic level.

Figure 4–15 shows some general facts about homeostatic mechanisms. For example:

- Homeostatic mechanisms are turned on, or activated, by changes in the extracellular fluid away from homeostasis.
- So-called sensor cells detect changes away from homeostasis. By way of nerve impulses or hormones, sensor cells act to initiate responses that make up a homeostatic mechanism.
- A homeostatic mechanism consists of responses that reverse the initial change that turned on the mechanism. Through reversal of the initial change, a homeostatic mechanism tends to maintain or restore homeostasis.
- Homeostatic mechanisms function on the principle of negative feedback. Basically, this means that a change in one direction feeds back in one way or another to bring about an opposite or negative change. Therefore, an increase in blood carbon dioxide concentration feeds back to cause a decrease in blood carbon dioxide concentration back towards its homeostatic level.

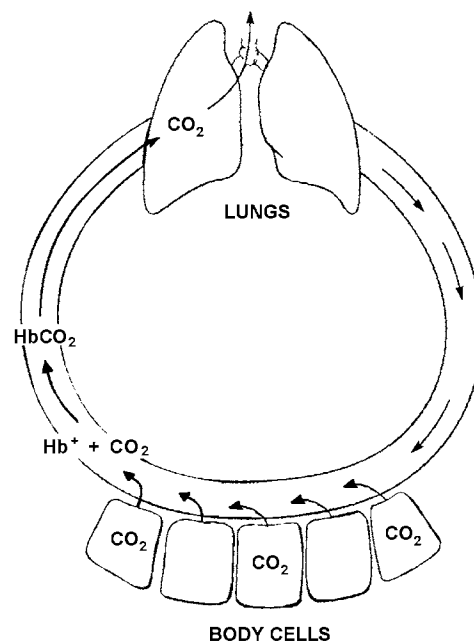


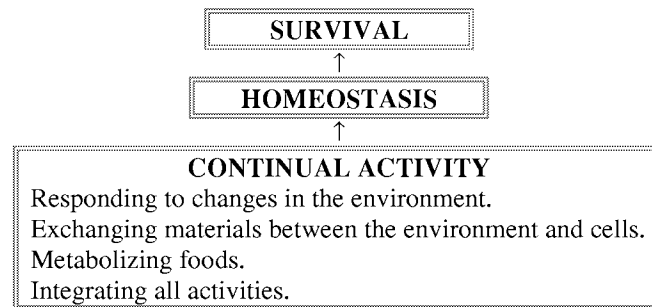
Figure 4–15. Homeostasis of blood carbon dioxide level.

Adaptive responses

Adaptive responses are responses that make up a homeostatic mechanism. They provide the means for the body to adapt to changes in its environment in ways that tend to maintain homeostasis and to promote healthy survival. Thanks to adaptive responses, the body can thrive as well as survive. Collectively, adaptive responses bring about adaptation. Adaptation is the successful coping of an organism with its environment. Successful adaptation supports healthy survival. Unsuccessful adaptation leads to disease or death.

025. Body function generalizations

It's a fact—the ultimate function of the human body is survival. This survival depends on homeostasis, which, in turn, depends on the certain continual activities. This process is illustrated as follows:

**Generalizations**

Here is a list of some generalizations about body function:

1. The body's most important business is survival—survival of itself and survival of the human species.
2. Survival is dependent on the body's ability to maintain or restore homeostasis; that is, a state of relative constancy of its internal environment.
3. Homeostasis is dependent on the body's ability to ceaselessly carry on many activities. The body's major activities include the following:
 - a. Responding to changes in the body's environment.
 - b. Exchanging materials between the environment and cells.
 - c. Metabolizing foods.
 - d. Integrating all of the body's diverse activities.
4. The cells' functions are, ultimately, the body's functions.

Body performance

Over the years, the body's ability to perform many of its functions gradually changes. For the most part, the body performs its functions least well at both ends of life; that is, in infancy and old age.

The body functions gradually become more and more efficient and effective during childhood. In contrast, the opposite is true during late maturity and old age. Body functions operate normally with maximum efficiency and effectiveness during young adulthood.

Developmental and aging processes

Developmental processes are the changes in function that occur during the early years of life. Those occurring during the later years are called aging processes. The functional capacities of the body are improved by the developmental processes. In contrast, many functions are diminished by the aging processes, and others show no effect.

Principle of complementary of structure and function

The principle of complementary of structure and function is one of the most unifying and important concepts in the study of anatomy and physiology. In lessons that follow, you'll again and again see that anatomical structures seem designed to perform specific functions. As such, they are intended to perform a unique and specialized activity. Because of this, they have a particular size, shape, form, or placement within the body.

It's often inappropriate to totally separate the two disciplines for study purposes because structure and function are so intimately related. As an example of the relationship between the levels of structural organization, refer back to the respiratory system shown in figure 4-1. The respiratory system has unique hair-like projections that cover cells in the lungs. In addition, there are specialized chemicals which have specific functions. The hair-like projections trap and aid in eliminating contaminants such as dust. As air moves out during exhalation, the chemicals help prevent collapse of the lungs. The structure of the lungs and respiratory tubes not only aid in the efficient and rapid movement of air but also make possible the exchange of critical respiratory gases such as oxygen and carbon dioxide between the air in the lungs and the blood. From this you can see that specialized chemicals, cells, tissues, and organs—working together as the respiratory system—supply every cell of our body with necessary oxygen and constantly remove carbon dioxide.

The human respiratory system you've just read about has a specialized nature and is different from that found in other living organisms. In trying to find an answer as to why that difference exists, scientists have (for hundreds of years) failed to grasp what biologists now understand. Biologists believe that as the functional needs of the human organism developed during the course of evolution, specialized anatomical structures (i.e., lungs) came into being and were continually modified to permit the body to function more effectively in a changing and often hostile environment.

As the body's functional needs changed, the anatomy of the respiratory system and, in particular, its relationship to the body as a whole also changed. The changes in the structure and function of the system most needed for survival evolved and became "inherited," and were passed on from one generation to the next. Those changes contributed to our understanding of the relationship between structure and function. This illustrates that not only does structure determine function, but that function itself influences the actual anatomy of an organism over time. The integration, interaction, development, modification, and control of functioning body structures are the main focus of current research in the study of human biology. This research is supported by the basic disciplines of anatomy and physiology.

As you study the structural and function levels of the body's organization in the remaining units of this course, make a conscious effort to apply the principles of complementarity of structure and function. When you do, you'll be able to better integrate what would otherwise be isolated factual information into a cohesive and understandable whole. Keep in mind that a memorized set of individual and isolated facts is soon forgotten; however, the component parts of an understandable anatomical structure that can be related to functional activity aren't.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

023. Body cavities

1. Name the two major body cavities and the subdivisions of each.
2. What organs are located in the mediastinum?

024. Homeostasis

1. What two fluids make up extracellular fluid?
2. Define homeostasis.
3. What are adaptive responses and what do they provide?
4. What's meant by the term adaptation?

025. Body function generalizations

1. What's the body's ultimate function?
2. At what point during a person's life are the body functions operating normally with maximum efficiency and effectiveness?
3. What are developmental processes?

4-3. Disease in the Human Body

Did you know there are three fundamentals of medical science? You've already learned two of them—anatomy and physiology. The third one is pathology, which is defined as the science of the essential nature of disease—including the structural and functional changes produced by the disorders.

Today's approach to the study of disease underscores the close relationship of the pathologic and physiologic aspects of each in treating any disorder of the body. The term used to describe this combined study of medical science is pathophysiology.

The basic medical sciences are broken down into the more fundamental disciplines of physics and chemistry. You need a knowledge of both to truly understand life's processes. You'll begin with some disease terminology necessary for continued study in this area.

026. Disease terminology

Specialized medical sciences

In this lesson, you'll begin by learning some of the more specialized medical sciences:

Specialized Science	Explanation
Bacteriology	Includes the study of the many beneficial plant-like and disease-producing organisms known as <i>bacteria</i> .
Microbiology	The science of microscopic plants and animals, usually emphasizing bacteria.
Protozoology	The study of one-celled animals.
Parasitology	The general study of parasites. A parasite is any organism that lives on or within another (called the <i>host</i>) at the host's expense.
Helminthology	The study of worms, particularly parasitic ones.
Etiology	The study of the cause of any disease, or the theory of its origin.

Disease incidence

All studies of disease normally include some indication of its *incidence*. The term *incidence* means "a disease's range of occurrence and its tendency to affect certain groups of individuals more than others." A disease's geographic distribution and its tendency to affect one sex, age group, or race more or less frequently than another is normally included in discussion(s) of disease incidence.

Disease classification

Diseases can also be classified on the basis of severity and duration. The terms used are as follows:

Term	Those diseases that
Acute	are severe but usually last a short time.
Chronic	usually less severe but are more likely to be continuous and recurring for a long period of time.
Subacute	intermediate and are somewhere between acute and chronic. These aren't quite so severe as acute infections, or as long lasting as chronic disorders.

Other disease terms

As you'd expect, there are many other disease terms. You won't learn all of them in this lesson; however, there are five of special importance:

Term	Definition
Idiopathic	Self-originating or without a known cause.
Communicable disease	A disease that can be transmitted from one person to another is called a communicable disease.
Epidemic	When a large amount of people in a given region acquire a disease at the same time, it's called an epidemic.
Endemic	When disease is found to a lesser extent but continuously in a particular region, it's said to be endemic to that area.
Pandemic	When disease is prevalent throughout an entire country or continent, or the whole world, it's called pandemic.

027. Disease—diagnosis, treatment, and prevention

Proper treatment of disease is a systematic process involving these precise steps:

1. Begin the diagnosis.
2. Know the symptoms and signs.
3. Determine any syndromes.
4. Begin therapy.

Diagnosis

Health care providers must determine the nature of a patient's illness before they're able to treat that illness—this determination is known as a diagnosis. In essence, a patient's diagnosis is the conclusion a health care provider draws from a number of put together facts put together.

Symptoms and signs

Before a health care provider can make an accurate diagnosis, the provider must know the symptoms (changes in the body felt by the patient) and the signs (also called objective symptoms) that the health care provider can observe.

Syndromes

Some diseases have a characteristic group of signs or symptoms. These groups are called syndromes. In other instances, the health care provider must do laboratory tests and evaluate the results in order to make a diagnosis.

Therapy

After a patient's disorder has been diagnosed, the health care provider normally prescribes a course of treatment—this is referred to as a patient's therapy. In some cases, a nurse may carry out many of the procedures or treatments prescribed by the health care provider.

NOTE: Nurses don't diagnose; however, they do play a very important role in the process of observing for signs, encouraging patients to talk about themselves and their symptoms, and in turn relating this information to the health care provider.

Disease prevention

Recently, health care providers of all types have taken an increased responsibility in disease prevention. Historically, the aim of health care providers has been to cure a patient of their disease. In contrast, modern day concepts of prevention seek to stop disease before it actually occurs. The goal is to keep people well through the promotion of health. There are a large number of organizations that exist for this purpose. On one end, we have the World Health Organization (WHO), which is an international organization—down to several different local and private organizations. As a pharmacy journeyman, you have a responsibility to educate your patients toward the proper maintenance of their health—both mental and physical.

028. Infectious disease

The most prevalent cause of disease in humans is the invasion of the body by a disease-producing microorganism. If you break down the word microorganism you have these two words:

1. Micro—meaning small.
2. Organism—meaning anything having life.

Consequently, microorganisms are tiny living things. In fact, they're much too small to be seen by the naked eye. A few other terms used in place of microorganism that you may be a little more familiar with are microbe and germ.

Surprisingly enough, most microorganisms are beneficial to man, or at least not harmful; however, there is a particularly small group that cause illnesses, these are known as pathogenic. Pathogens are

any disease-causing organism. Another common term is *infection*. This term is used to describe “any condition where the body is invaded by pathogens, resulting in adverse effects.” The term infection can be further broken down into local and generalized or systemic infections. Local infections are restricted to a relatively small area of the body. Generalized or systemic infections are infections where the whole body is affected. Systemic infections are most commonly spread by the bloodstream.

Transmission

Microorganisms are transmitted from infected humans, insects, or animal hosts to susceptible individuals. This transfer may be of two types:

1. Direct.
2. Indirect.

Direct

In direct transmission, an infected human can transfer their microorganisms to other individuals through *direct* contact by shaking hands, kissing, or sexual intercourse.

Indirect

Indirect transmission involves touching objects that have been contaminated by an infected person. This occurs when microorganisms are transferred by bedding, toys, food, dishes, or other items. There are also instances when insects deposit infectious material on food, skin, or clothing. Pets can also be the source of a number of infections.

Entry and exit of microorganisms

Microorganisms can enter the body through several different avenues. Here are some examples:

- Skin.
- Respiratory tract.
- Digestive system.
- Urinary system.
- Reproductive system.

These portals of entry can also serve as exit routes. Often times, discharges from the respiratory and intestinal tracts can spread infection through contamination of the air, through contamination of hands, and through contamination of food and water supplies.

029. Characteristics of microorganisms

Microorganisms are living things of a very primitive order. In bygone times, early microscopes lacked high resolving power; consequently, many species of organisms were unknown. Two of these are rickettsias and certain viruses. Both of them are somewhat simple organisms that are classified in a separate kingdom known as Protista.

Cells

Higher forms of life are made up of a vast number of cells. The life forms are occupied to a greater or lesser degree in specialized tasks. However, most microorganisms are made up of one cell in which the processes of life occur. These processes include nutrition, growth, reproduction, response to environment, and so on.

The word *Protista* means “first.” Protista is used to designate a combination of one-celled organisms and certain very simple multicellular organisms. The Protista organisms shown in figure 4–16 are of medical interest. As you can see, they include the following:

- Viruses.
- Bacteria.
- Protozoa.
- Algae.
- Some fungi.

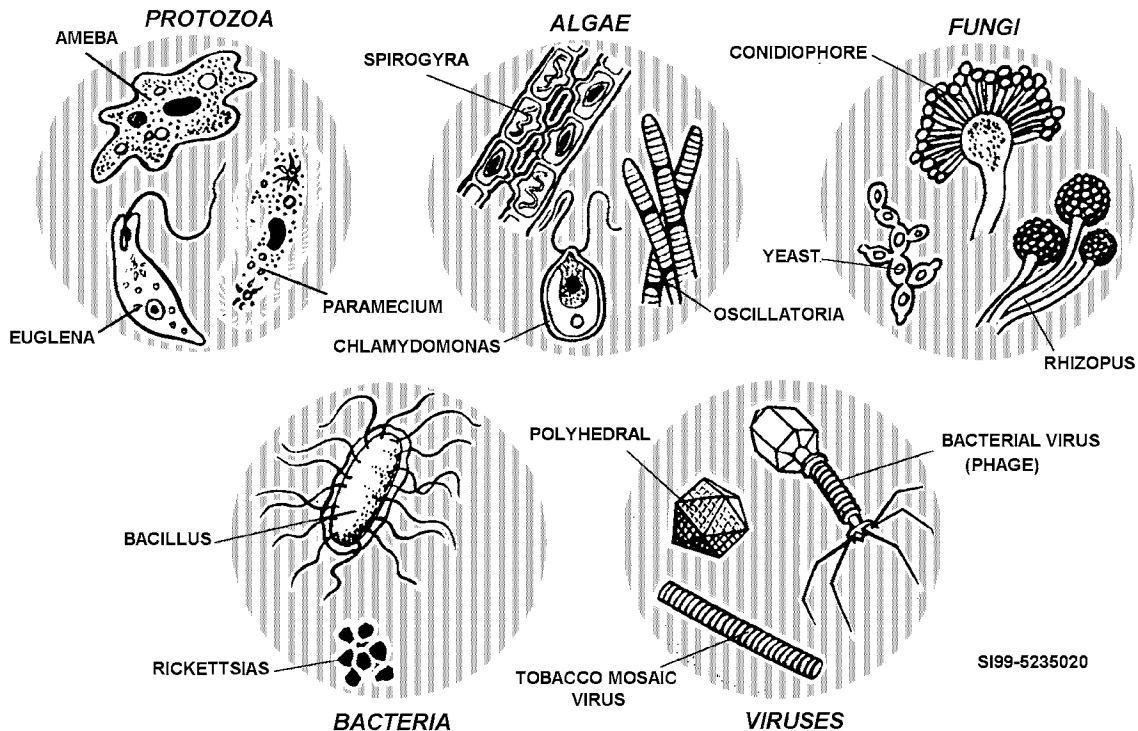


Figure 4–16. Protista organism.

Viruses

When compared to molecules, viruses are mere particles. Viruses aren't like ordinary molecules; they contain genetic material and are able to reproduce.

Bacteria

Bacteria are one-celled plants. Collectively, they're the largest group of pathogens. Most are harmless to man, yet, are beyond doubt, essential to the continuation of all life on earth. Dead animals and plants are decomposed and transformed into substances that enrich the soil by actions of bacteria. Bacteria have the ability to render sewage harmless. There's even one type of bacteria that transforms the nitrogen in the air into a form that can be used by plants. This process is called nitrogen fixation. Some farmers take advantage of this by allowing their fields to lie untilled so that the nitrogen of its soil can be replenished.

In order to see bacteria, you must use a microscope. Normally, you need to stain bacteria with colored dyes in order to view their structures clearly. To give you a vague idea of their size, you could take anywhere from 10 to 1,000 bacteria, line them up, and they would span the head of a pin (depending on the species).

Bacteria's environment is one of moisture and food materials. Bacterial spores are resistant forms of bacteria that are able to tolerate long periods of dryness or other antagonistic conditions. Other bacteria can swim rapidly by themselves using threadlike appendages called flagella. Depending on the species, bacteria's requirement for water, food, oxygen, temperature, and other factors may vary.

Pathogenic bacteria are the most at home within the "climate" of the human body. When bacteria's living conditions are perfect, the organisms reproduce (by splitting in two) at a rapid rate. When bacteria succeed in overpowering the human body's natural defenses, they can cause damage by two different methods by:

1. Producing poisons, or toxins.
2. Entering the body tissues and growing within them.

The vast number of bacteria makes their classification complicated. For the purpose of this lesson, we group them based on their shape and arrangement as seen with a microscope. Examples are shown in figures 4-17 and 4-18.

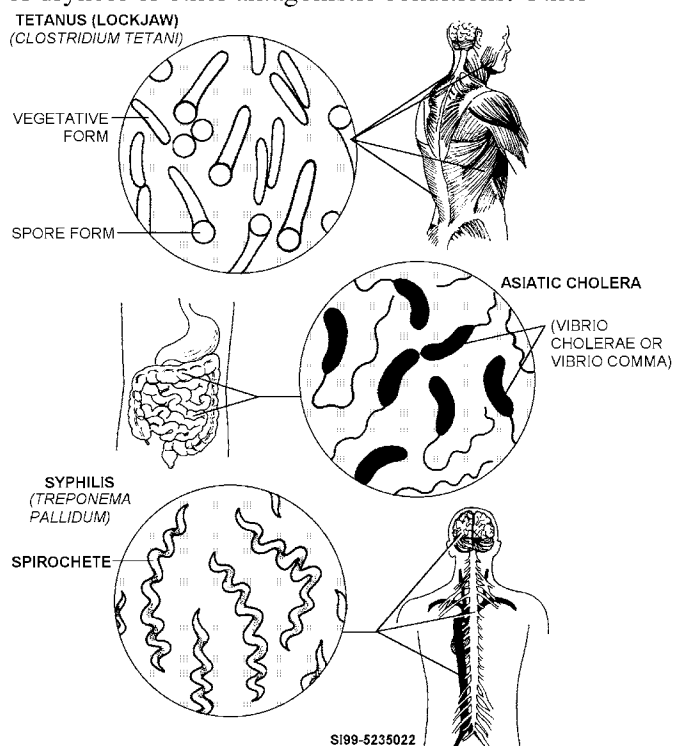


Figure 4-18. Curved-type bacteria.

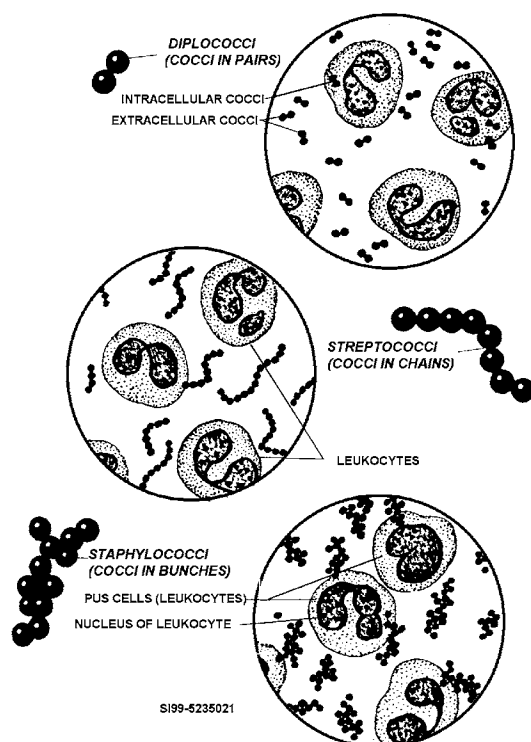


Figure 4-17. Spherical-type bacteria.

Rod-shaped cells—bacilli

These cells are straight and slender, similar to match sticks. Some are cigar-shaped with a tapered end. Typical bacillary diseases include the following:

- Tetanus.
- Diphtheria.
- Tuberculosis.
- Typhoid fever.
- Legionnaire's disease.

Spherical cell—cocci

These cells look like dots. They're seen in characteristic arrangements. They are:

- Diplococci (diplo- meaning double) are in pairs
- Streptococci (strepto- meaning chain) are arranged in chains, similar to a string of beads.
- Staphylococci (staphlo- meaning bunch of grapes) is arranged in large clusters.

Some of the disease caused by diplococci are gonorrhea and meningitis; whereas, streptococci and staphylococci are responsible for a wide variety of infections.

Curved rods

These are also seen in characteristic arrangements. They are:

- Vibrio, which looks like a comma, having only a slight curvature.
- Spirillum (plural spirilla), is shaped like a corkscrew.
- Spirochetes. This bacteria is very similar to spirilla, but is capable of waving and twisting motions.

The disease cholera is caused by vibrio. Syphilis is the most serious and widespread spirochetal infection. In syphilis, the spirochetes enter the body at the point of contact through the genital skin or mucous membranes. There, they set up their systemic infections by traveling to the bloodstream.

Rickettsias and chlamydias

Rickettsias and chlamydias are currently classified as bacteria, even though they're considerably smaller than most bacteria. These microorganisms can exist **ONLY** inside living cells. They're called parasites because they exist only at the expense of their host. They're also further classified as obligate parasites because they can only grow within living cells.

Rickettsias

The rickettsias are responsible for causing quite a few serious diseases in man. Examples are:

- Typhus.
- Rocky Mountain spotted fever.

The majority of these organisms are transmitted through the bites of lice, ticks, and fleas.

Chlamydias

The chlamydias are smaller than the rickettsias. Chlamydia is the causative organism in trachoma—a serious eye infection that ultimately causes blindness. It's also responsible for causing the following:

- Parrot fever or psittacosis.
- The venereal disease lymphogranuloma venereum.
- Some respiratory diseases.

Fungi

Another large group of simple plants are known as true fungi. There are only a few types of fungi that are pathogenic. Fungi lack the green pigment, chlorophyll, that enables higher plants to utilize the energy of sunlight in carrying out their life process. Consequently, they're in a lower order in plant life than bacteria, even though they're much larger and more complicated. One thing they do have in common with bacteria is that they prefer dark and damp places to grow. The fungi's reproductive cells are resistant "seeds" or spores.

Some examples of fungi that may be familiar to you are mushrooms, puffballs, bread molds, and yeast (commercially available yeast cakes used in baking and brewing). Disease caused by fungi are called mycotic infections (myco- means fungus). Athlete's foot and ringworm are examples. Tinea capitis (involving the scalp) and tinea corporis (which can be found almost anywhere on the nonhairy parts of the body) are two common types of ringworm. There are very few diseases caused by fungi, but the ones that are, are very dangerous and all fungi diseases are difficult to cure. Pneumonia can also be caused by inhaling dust particles that contain fungal spores.

Viruses

As small as bacteria seem, viruses are even smaller. Viruses are so small that they aren't visible in the ordinary light microscope. They can only be seen in an electron microscope. In fact, viruses are the smallest known infectious agents. They have a few of the fundamental properties of living matter, yet they aren't cellular and they have no enzyme system. They have something in common with the rickettsias and chlamydias; that is, they're obligate parasites—they can only grow within a living cell. In contrast to the rickettsias in chlamydias, viruses aren't usually susceptible to antibiotics.

Currently, there's no universally accepted classification of viruses except to say there are a large number. For the most part, viruses are classified in relation to the disease they cause, for example:

- Measles.
- Poliomyelitis.
- Hepatitis.
- Chickenpox.
- The common cold.

Protozoa

This is the one and only group of microbes that can be definitely classified as animals due to their mode of nutrition. The protozoa are one-celled like bacteria, but they're much larger. Protozoa are found in almost any body of water, from moist grass, to mud puddles, to the ocean. There are four main divisions of protozoa:

Division	Explanation
Amebae.	This is an irregular blob of protoplasm that moves itself by extending a branch of itself (a "false foot") and then flowing over it. Amebic dysentery is caused by a pathogen belonging to this group.
Ciliates.	Are covered with tiny hairs called cilia, which produce a wave motion to propel the organism.
Flagellates.	Are propelled by their long whip-like filaments called flagella.
Sporozoa.	This protozoon isn't able to propel itself. They're parasites, unable to grow without their host. A member of this group causes malaria.

Figure 4-19 shows some of the pathogenic protozoa and their portals of entry.

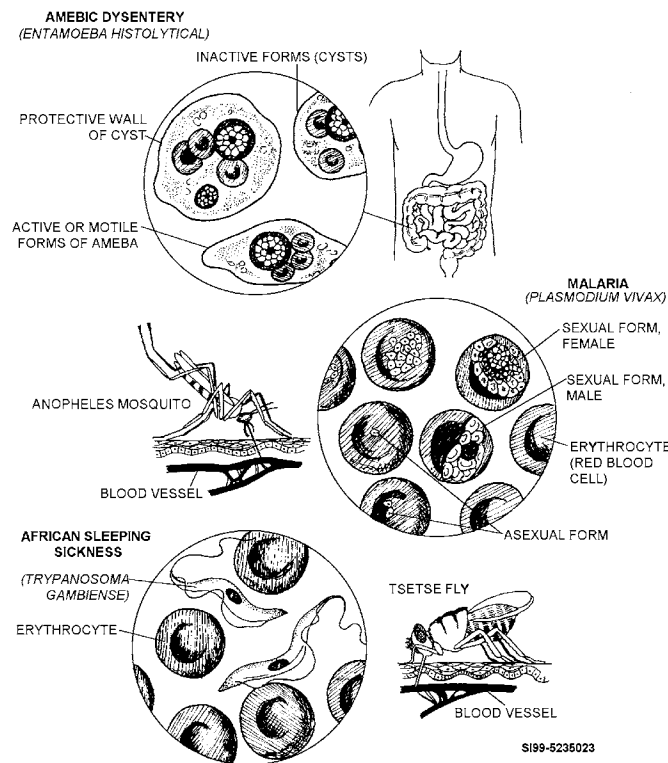


Figure 4-19. Pathogenic protozoa.

030. Characteristics of helminths

A large number of helminths (worms) are parasitic by nature and select the human organism for their host. If you'll recall, invasion by any form of organism is usually referred to as an infection. Additionally, when parasitic worms are found in the body, this is called an infestation. Most worm infestations necessitate the use of a microscope to discover their eggs and larval forms. Essentially, there are two categories of worms:

1. Roundworms.
2. Flatworms.

Roundworms

Ascaris is the most common of the intestinal worms. It's very prevalent in many parts of Asia, where it's found mostly in the larval form. *Ascaris* is also found in the United States, especially in children of the rural south. This worm looks similar to the earthworm (fishworm) and may be present in such a large quantity that intestinal obstruction occurs. Adult worms produce eggs that are very resistant, having the ability to live in soil during either freezing or hot dry weather and can't be destroyed, even with the use of strong antiseptics. The embryo worms develop inside the eggs deposited with excreta in the soil, and later arrive at the digestive system of a human body by means of contaminated food. This condition can be discovered through routine stool examination.

Pinworms

The seat, or pinworm, is another fairly common infestation, especially in children. It's also very hard to control and eliminate. Pinworms average a little less than $\frac{1}{2}$ inch in length and inhabit the lower portion of the alimentary tract. The adult female moves outside to the area of the anus to lay her thousands of eggs. These eggs are frequently transferred by children's fingers from the itching of the anal area to the mouth. Children can also infect others by this means. Additionally, pinworm eggs that

are released from the body also pose a hazard, and may live in the external environment for several months. If patients are to rid themselves of these worms, they'll need to be patient, use every precaution, and pay careful attention to the instructions of their health care provider. It's essential that the patients wash their hands, keep their fingernails clean, and avoid sucking their fingers.

Hookworms

These parasites live in the small intestine. Hookworms are very dangerous because they suck blood from their host, resulting in such a severe anemia (blood deficiency) that the patient becomes sluggish, both physically and mentally. The majority of patients become susceptible to various chronic infections due to their extremely reduced resistance caused by their large and continuous blood loss. The worms lay thousands of eggs, then distribute them in the soil through contaminated excreta. The eggs develop into small larvae that are able to penetrate the intact skin of bare feet. Their next step is to enter the blood, and via circulating fluids, the lungs, and the upper respiratory tract. They finally reach the digestive system. This type of infestation is preventable by properly disposing of excreta, sanitation methods, and the wearing of shoes in areas where the soil is contaminated.

Other roundworms

Most roundworms are transmitted by excreta, but the small *Trichinella*, which is found in pork and other muscle foods, is an exception. *Trichinella* enclose themselves in a cyst (a sac) inside the muscles of rats, pigs, and man. If pork isn't cooked well enough, these sacs are dissolved by the host's digestive juices, and the trichinella mature and travel to the muscles where they again encase themselves. This disease is called Trichinosis.

Another one of the threadlike worms causes filariasis. This tiny worm is transmitted by flies and mosquitoes. These worms grow very rapidly, causing various body disturbances. If left untreated and the lymph vessels become clogged by filaria, the result is a condition known as elephantiasis. Patients with elephantiasis experience a tremendous enlargement of their lower extremities and scrotum. Filariasis is most common in tropical and subtropical areas, like southern Asia and many of the South Pacific islands.

Flatworms

Some flatworms look like long ribbons, while others have the shape of a leaf. An example is tapeworms. They may grow in the intestinal tract to a length from 5 to 50 feet (fig. 4-20). Infected, improperly cooked meats spread them. Just like most intestinal and worm parasites, the tapeworm's reproductive system is very highly developed. So much so that each worm can produce an unbelievably large amount of eggs, which, in turn, could contaminate food, water, and soil.

Leaf-shaped flatworms, known as flukes, may invade various parts of the body, to include the lungs, blood, liver, and intestine.

NOTE: Loss of proglottids (segments) doesn't cause injury to the parasite as long as the head stays attached to the host's intestine. Each proglottid accommodates testes and an ovary, therefore fertilization occurs between adjacent segments.

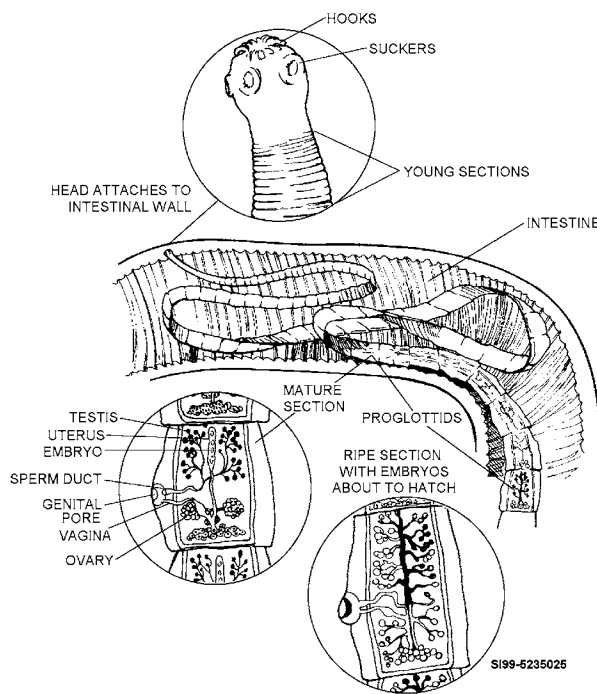


Figure 4-20. Tapeworm.

031. Infection control

You'd have to search long and hard to find a place on this earth that's naturally free of microorganisms. However, there is one place—the interior of normal body tissue. In contrast, the external body surfaces, the lining membranes, and inside tubes and organs that are connected to the outside—like the throat, mouth, nasal cavities, and large intestine—will house both harmless and pathogenic microbes in abundance. Our bodies have natural defenses against these microbes. In fact, when the natural defenses are effectual, people may carry around many microbes without any ill effects. Yet, when a person's resistance is lowered, infection can occur. In this lesson you'll study the following subjects:

- How microorganisms are spread.
- Health considerations.
- Aseptic techniques.

Spread of microorganisms

There's an infinite number of ways that microbes are spread. Person-to-person contact is the simplest means. The more populated the conditions, the larger the chance of epidemic break out. Our atmosphere is a delivery van for microorganisms. Even though microbes are unable to fly, the dust in our air is full of them. The atmosphere in close quarters is more contaminated by bacteria-laden droplets discharged by sneezing, coughing, and even normal conversation. Another method for the spread of these pathogens is pests, such as rats, mice, fleas, lice, flies, and mosquitoes. The lack of sunlight and the prevalence of dirt act as assistants for microbial growth.

There are some areas where people live in a combination atmosphere of crowded conditions and poor sanitation. These people have a much higher incidence of infection than most people. In addition, these people may also have a lower resistance because of poor nutrition and other undesirable health practices. Consequently, epidemics are likely to begin in these areas.

Health considerations

Throughout time, civilized societies have established and enforced measures designed to protect the health of their population. Most of these practices are aimed at preventing the spread of infectious organisms. A few examples of health considerations are discussed here:

- Garbage and sewage disposal.
- Water supply purification.
- Food contamination prevention.
- Pasteurized milk.

Garbage and sewage disposal

In years gone by, people would dispose of their household “slop” by several expedient methods—such as throwing it out the window. As you can imagine, great epidemics were inevitable. Today, we divert our sewage into processing plants, where harmless bacteria are employed to destroy the pathogens. Furthermore, the sludge that results from this process can be used as an excellent fertilizer.

Water supply purification

Water supplies in the United States are normally purified by a filtering process, and a close and constant watch is kept on its microbial population. At times, some drinking water sources are polluted with untreated sewage and may be contaminated with dangerous pathogens such as typhoid bacilli, the viruses of polio and hepatitis, and dysentery amebae. Chemical and industrial waste (such as asbestos fiber, acids, and detergents from residences and industry, along with pesticides used in agriculture) compound the problem of maintaining a pure source of drinking water.

Food contamination prevention

Food is a natural breeding place for many dangerous pathogens. Because of this, there are numerous national, state, local, and military laws or regulations that seek to prevent the outbreak of disease by contaminated food. In addition, certain animal diseases (tuberculosis, tularemia) can be passed on by food. Two organisms that cause food poisoning are as follows:

1. The rod-shaped botulism bacillus (*Clostridium botulinum*).
2. The grape-like “staph” (*Staphylococcus aureus*).

Most cities and all USAF installations have sanitary regulations that require periodic inspection of food-handling establishments and medical examination of personnel.

Pasteurized milk

Pasteurization makes milk free of pathogens. Pasteurization is a process where milk is heated to 145°F (63°C) for 30 minutes, and then allowed to cool rapidly before being bottled. Pasteurized milk still contains microbes, but not any harmful ones. An alternate method of pasteurization using slightly higher temperatures and a shorter time period is sometimes used, and has shown satisfactory results.

Aseptic techniques

All health care personnel use specialized procedures for the purpose of reducing the influence of pathogenic organisms to a minimum. Two important terms come into play in this endeavor:

1. *Sepsis*, which can be briefly defined as “poisoning due to pathogens.”
2. *Asepsis* is the opposite; that is, a condition where no pathogens are present.

The procedures used to kill, remove, or prevent the growth of microbes are called aseptic techniques. It's very easy to confuse the terms associated with aseptic techniques; therefore, take a look at the three most common terms and their definitions:

1. Sterilization.
2. Disinfection.
3. Antisepsis.

Sterilization

In order to sterilize an object, you must kill *every* living microorganism on it. Certain areas in the hospital are kept as sterile as possible. Especially important are operating and delivery rooms. The normal method of sterilization is live steam under pressure, or dry heat. It only takes 4 minutes of exposure to boiling water to kill most pathogens. However, there are very few types of pathogenic bacteria capable of developing a highly resistant, armor-like coat. Those that do are called spores. As you'd expect, spores are very hard to kill. To guarantee destruction of all spore-forming organisms, the sterilization time and temperature must be increased in comparison to what's used to kill most pathogens.

Disinfection

Any measure used to kill all pathogens (except spores), but not necessarily all harmless microbes, is known as disinfection. The disinfecting agents (called disinfectants) are chemical in nature. Iodine and phenol (carbolic acid) are examples of disinfectants. In addition, the terms bactericide and germicide are two other terms used synonymously with disinfectant.

Antisepsis

Antisepsis refers to any process in which pathogens aren't necessarily killed, but are prevented from multiplying—a state called bacteriostasis. Antiseptics are less powerful than disinfectants.

032. Chemotherapy

Any treatment of a disease by the administration of a chemical agent is called chemotherapy. This treatment can be for any disease and by any natural or artificial (synthetic) substance. In this lesson you'll study two types:

1. Antibiotics.
2. Antineoplastic agents.

Antibiotics

Antibiotics are chemical substances produced by living cells. They have the power to kill or arrest the growth of pathogenic microorganisms by disturbing vital chemical processes within them. Ideally, you want to use antibiotics that aren't toxic to the host when treating infectious diseases. The majority of antibiotics are derived from molds and soil bacteria. The first widely used antibiotic was penicillin. It's made from a common blue mold called penicillium. Another well known antibiotic is streptomycin, which belongs to a group of antibiotics produced by Streptomyces—a type of soil bacteria.

The development of antibiotics has been of immeasurable benefit to mankind; however, it has also given rise to serious complications. One complication is secondary infections. To give you an idea of how secondary infections can sometimes complicate matters, we'll use an example. Say you have a female patient being given an antibiotic to combat bacteria that are causing a specific disease. Coexisting in her body with these pathogens, the patient also has a second kind of disease organism. In this case, a fungus. Up until the time the antibiotic was administered, the fungus was of no danger to the patient because its growth had been suppressed by the bacteria. When you administered the antibiotic, you remove the natural enemy of the fungus (the bacteria). With its natural enemy removed, there isn't anything to stop the fungus from growing freely and setting up new infections that are very difficult to cure.

One more danger of antibiotic usage is the development of an allergy (or abnormal reactions) to these substances by certain patients. Keep in mind that allergic reactions can have very serious consequences.

In addition to allergic reactions, a new complication has become known. It arises because of the widespread use of antibiotics. Because of this widespread use, there's a natural evolution of strains of pathogens that are resistant to certain medications. One of the major problems in hospitals today is the prevalence of antibiotic-resistant staphylococci, which causes serious infections that could possibly be unresponsive to chemotherapy.

Antineoplastic agents

This is a group of chemotherapeutic drugs used extensively to treat cancers. In up-coming volumes of this course, you'll learn about the chemotherapeutic agents associated with each system within the human body. For now, we'll just say that antineoplastic agents are toxic to the host as well as to the tumor cells and must be administered by a person with an understanding of the complications caused by these drugs.

033. Pathogenic identification by the laboratory

In order to identify bacteria and other organisms, specimens are obtained from patients. The most frequently studied specimens include blood, spinal fluid, urine, sputum, and swabbings from certain areas. Some specimens are collected by using swabs from the nose, throat, eyes, and cervix, and ulcers and other infected areas.

Laboratory procedures

There are many different types of bacteria that must be identified. Laboratory personnel are required to use several different procedures to determine which organism is present in material obtained from patients.

Dyes

The most commonly used method for beginning the process of identification is the application of colored dyes, known as stains, to a thin smear of the specimen on a glass slide. The smear is treated with acid after being stained with a reddish dye (carbol-fuchsin). The majority of bacteria will lose their stain shortly after the application of acid. Two exceptions are the organisms that cause tuberculosis and leprosy. These organisms are said to be acid-fast.

Gram-stain

Gram-stain is another commonly used method for identifying bacteria. A bluish dye (such as methyl violet or gentian violet) is applied and then a weak solution of iodine is added. This produces a color fast combination with some organisms. In this method, the use of alcohol or other solvents doesn't remove the dye. These bacteria are said to be gram positive. Some examples of gram positive organisms are as follows:

- The pathogenic staphylococci and streptococci.
- The cocci that causes certain types of pneumonia.
- The bacilli that produce diphtheria, tetanus, and anthrax.

Gram-negative

There are other organisms from which the coloring can be removed by the use of solvents (such as acetone and alcohol). These organisms are said to be gram-negative. A few examples of gram-negative organisms are as follows:

- Those diplococci that cause gonorrhea and epidemic meningitis.
- Bacilli that produce typhoid fever, influenza, and one type of dysentery.
- Colon bacillus, normally located in the bowel.
- Cholera vibrio.

Special stains

There are several organisms that don't stain with any of the commonly used dyes. Some examples of these are the spirochete of syphilis and the rickettsias. Special staining techniques are used to identify these organisms.

Other laboratory techniques

There are other laboratory techniques used, besides staining techniques, to identify bacteria:

1. Growing bacteria for study by culture—a process using substances called *media* (such as nutrient broth or agar) that bacteria can use as food.
2. Studying the ability of bacteria to act on (ferment) various carbohydrates (sugars).
3. Counting bacteria in a given specimen by specialized processes.
4. Inoculating animals and analyzing their reactions to the injections.
5. Studying bacteria by serologic (blood tests), mostly based on the antigen-antibody reaction.

Most bacteria can be grown on artificial media devoid of living cells, and they're frequently described according to their growth requirements on these media. Here are some examples:

Aerobic

Bacteria that require high levels of oxygen are called aerobic.

Anaerobic

Bacteria that grow best in the absence of oxygen are termed anaerobic.

Microaerophilic

Bacteria that thrive with limited amounts of oxygen are designated microaerophilic.

Facultative anaerobes

Bacteria that grow well both in the presence and absence of oxygen are called facultative anaerobes.

As you can see, laboratory procedures play a vital role in the process of diagnosing disease.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

026. Disease terminology

1. Define the following terms:

- a. Etiology.
- b. Incidence.
- c. Acute.
- d. Chronic.
- e. Idiopathic.
- f. Epidemic.
- g. Endemic.

027. Disease–Diagnosis, treatment, and prevention

1. Define the following terms:

a. Diagnosis.

b. Symptom.

c. Sign.

d. Syndrome.

e. Therapy.

028. Infectious disease

1. Define the following terms:

a. Infection.

b. Pathogen.

2. List the five different avenues that microorganisms may use to enter the body.

029. Characteristics of microorganisms

1. What are the three characteristic shapes of bacterial cells?

2. What cells cause tetanus, diphtheria, tuberculosis, typhoid fever, or Legionnaire's disease?

3. What cells cause gonorrhea and meningitis; streptococci and staphylococci?

4. What cells cause syphilis?

5. In what ways are bacteria beneficial to man?
6. How do rickettsias and chlamydias differ from other bacteria in size and living habits?
7. What's the typical mode of transmission of rickettsial infections?
8. What microbial group is classified as animals?
9. What are some common fungus infections.
10. Name two diseases caused by rickettsias and two due to chlamydias.
11. Name five viral diseases. Describe the effects of antibiotics on these diseases.

030. Characteristics of helminths

1. Name three types of parasitic worms.
2. What's the most common intestinal worm?
3. How are trichinella transmitted?

031. Infection control

1. What are the three most common ways by which disease organisms are spread?
2. What method is used by cities to purify water?
3. Which animal diseases can be passed on by food?

4. Define the following terms:

a. Sepsis.

b. Sterilization.

c. Disinfection.

d. Antisepsis.

032. Chemotherapy

1. What are some disadvantages in the use of antibiotics?

2. What are antineoplastic agents?

033. Pathogenic identification by the laboratory

1. What are laboratory stains and why are they used?

2. Name examples of the following:

a. Acid-fast.

b. Gram-negative.

c. Gram-positive organisms.

3. Define aerobic and anaerobic bacteria.

Answers to Self-Test Questions

022

1. (1) Metabolism.
(2) Irritability.
(3) Conductivity.
(4) Contractility.
(5) Growth.
(6) Reproduction.
2. To supply the basic building blocks for next higher level of body structure—the cellular level.
3. An organization of many similar cells that are specialized to perform a certain function.
4. (1) Epithelial, (2) connective, (3) muscle, and (4) nervous.
5. An organization of several different types of tissues so arranged that, collectively, they can perform a special function.
6. The systems.
7. Protection.
8. (1) Communication, (2) integration, and (3) control of body functions.
9. The cardiovascular and lymphatic systems.
10. (1) The movement of fluids and certain large molecules from the tissue spaces surrounding the cells.
(2) Movement of fat-related nutrients from the digestive tract back to the blood.
11. To clear or clean the blood of the many waste products that are continually produced by metabolism of foodstuffs in the body cells.

023

1. (1) Ventral—thoracic or chest cavity and the abdominopelvic cavity. (2) Dorsal—cranial and spinal cavities.
2. Heart, trachea, right and left bronchi, esophagus, thymus, various blood vessels, thoracic duct and other lymphatic vessels, various lymph nodes, and nerves.

024

1. Interstitial fluid and blood plasma.
2. The relatively constant states maintained by the body.
3. Responses that make up a homeostatic mechanism. They provide the means for the body to adapt to changes in its environment in ways that tend to maintain homeostasis and to promote healthy survival.
4. The successful coping of an organism with its environment.

025

1. Survival.
2. During young adulthood.
3. Changes in function that occur during the early years of life.

026

1. a. Etiology—the study of the cause of any disease, or the theory of its origin.
b. Incidence—a disease's range of occurrence and its tendency to affect certain groups of individuals more than others.
c. Acute—those diseases that are severe but usually last a short time.
d. Chronic—those diseases that are usually less severe but are more likely to be continuous and recurring for a long period of time.
e. Idiopathic—"self-originating" or "without a known cause."
f. Epidemic—when a large amount of people in a given region acquire a disease at the same time.

- g. Endemic—when disease is found to a lesser extent than that of an epidemic, but continuously in a particular region.

027

1. a. Diagnosis—the determination made by health care providers as to the nature of a patient’s illness.
- b. Symptom—changes in the body felt by the patient.
- c. Sign—symptoms that are observed by a health care provider.
- d. Syndrome—a characteristic group of signs or symptoms associated with a disease.
- e. Therapy—a course of treatment prescribed by a health care provider after a patient’s disorder has been diagnosed.

028

1. a. Infection—any condition where the body is invaded by pathogens, resulting in adverse effects.
- b. Pathogen—any disease-causing organism.
2. (1) Through the skin.
- (2) Respiratory tract.
- (3) Digestive system.
- (4) Urinary system.
- (5) Reproductive system.

029

1. (1) Rod shaped cells, (2) spherical cells, and (3) curved rods.
2. Rod-shaped cells.
3. Spherical cells.
4. Curved rods: syphilis.
5. Bacteria aid in the decomposition and transformation of dead animals and plants into substances that enrich the soil. Bacteria have the ability to render sewage harmless. Certain bacteria can transform the nitrogen in the air into a form that can be used by plants.
6. They’re smaller than most bacteria, and can only exist inside living cells.
7. Through the bites of lice, ticks, and fleas.
8. Protozoa.
9. Athlete’s foot and ringworm.
10. (1) Rickettsias—typhus and Rocky Mountain spotted fever. (2) Chlamydias—trachoma, parrot fever or psittacosis, the venereal disease lymphogranuloma venereum, and some respiratory diseases.
11. (1) Measles, (2) poliomyelitis, (3) hepatitis, (4) chickenpox, and (5) the common cold. Viruses aren’t usually susceptible to antibiotics.

030

1. (1) Roundworms, (2) pinworms, (3) hookworms.
2. Ascaris.
3. They enclose themselves in a cyst (a sac) inside the muscles of rats, pigs, and man.

031

1. (1) Person-to-person contact, (2) the atmosphere, and (3) by pests.
2. A filtering process.
3. Tuberculosis and tularemia.
4. a. Poisoning due to pathogens.
- b. Killing *every* living microorganism.
- c. Any measure used to kill all pathogens (except spores), but not necessarily all harmless microbes.
- d. Any process in which pathogens aren’t necessarily killed, but are prevented from multiplying.

032

1. Secondary infections, allergy or abnormal reactions, resistant strain of pathogens.
2. A group of chemotherapeutic drugs used extensively to treat cancers.

033

1. The application of colored dyes to a thin smear of a specimen on a glass slide. To determine which organisms are present in material obtained from patients.
 - a. Acid fast—organisms that cause tuberculosis and leprosy.
 - b. Gram-negative—the pathogenic staphylococci and streptococci; the cocci that causes certain types of pneumonia, and the bacilli that produce diphtheria, tetanus, and anthrax.
 - c. Gram-negative—diplococci that causes gonorrhea and epidemic meningitis, and the bacilli that produce typhoid fever, influenza, and one type of dysentery. The colon bacillus, normally located in the bowel, and the cholera vibrio are also gram-negative organisms.
3. Bacteria that require high levels of oxygen are called *aerobic*; and those that grow best in the absence of oxygen are termed *anaerobic*.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to ECI Form 34, Field Scoring Answer Sheet.

Do not return your answer sheet to ECI.

54. (022) What is the *lowest* level of organization in the body?
- a. Organ.
 - b. Tissue.
 - c. Cellular.
 - d. Chemical.
55. (022) Which human body system has the *primary* function of protection?
- a. Integumentary.
 - b. Circulatory.
 - c. Endocrine.
 - d. Nervous.
56. (022) Which human body system is responsible for cleaning the blood of waste products?
- a. Urinary.
 - b. Digestive.
 - c. Lymphatic.
 - d. Cardiovascular.
57. (023) Which major body cavity contains the thoracic and abdominopelvic cavities?
- a. Cranial.
 - b. Ventral.
 - c. Dorsal.
 - d. Spinal.
58. (023) Which organ lies within the pelvic cavity?
- a. Stomach.
 - b. Kidneys.
 - c. Bladder.
 - d. Spleen.
59. (024) Extracellular fluid is made up of
- a. interstitial and intercellular fluids.
 - b. an interstitial fluid and blood plasma.
 - c. an intercellular fluid and whole blood.
 - d. an intercellular fluid and blood plasma.
60. (025) The principle of “complementary of structure and function” is that
- a. accessory organs are paired.
 - b. all structures continually exchange materials between the environment and cells.
 - c. body functions develop and act more effectively throughout the developmental process.
 - d. anatomical structures are sized, formed, and placed in the body based on their specific function.

61. (025) What is the *ultimate* function of the human body?
- Survival.
 - Homeostasis.
 - Integration of activities.
 - Metabolization of food.
62. (026) What term describes the study of one-celled animals?
- Parasitology.
 - Protozoology.
 - Microbiology.
 - Helminthology.
63. (026) What type of disease is “self-originating” or “without a known cause?”
- Endemic.
 - Pandemic.
 - Idiopathic.
 - Communicable.
64. (027) As a pharmacy technician, what is your responsibility toward the proper maintenance of your patients’ health?
- Ensuring medication compliance.
 - Quality medication delivery.
 - Patient/provider liaison.
 - Patient education.
65. (028) A disease can be *indirectly* spread by
- kissing.
 - shaking hands.
 - sharing dishes.
 - sexual intercourse.
66. (029) Resistant forms of bacteria that are able to tolerate long periods of dryness or other antagonistic conditions are called
- flagella.
 - streptococci.
 - Bacterial spores.
 - Pathogenic Bacteria.
67. (029) Which bacteria are also considered parasites?
- Cocci.
 - Bacilli.
 - Rickettsia.
 - Spirochete.
68. (029) Diseases that are caused by fungi are called
- infestations.
 - syndromes.
 - trichinellas.
 - mycotic infections.
69. (030) Which helminth is the *most* common of the intestinal worms?
- Ascaris.
 - Pinworms.
 - Tricinella.
 - Hookworms.

70. (030) What helminth lives in the small intestine and sucks blood from its host?
- a. Pinworms.
 - b. Flatworms.
 - c. Hookworms.
 - d. Roundworms.
71. (031) What term *best* describes the type of aseptic technique where pathogens are *not* necessarily killed, but prevented from multiplying?
- a. Asepsis.
 - b. Antisepsis.
 - c. Disinfection.
 - d. Sterilization.
72. (031) The *simplest* means of spreading microbes is by
- a. sewage disposal.
 - b. food contamination.
 - c. water contamination.
 - d. person-to-person contact.
73. (032) What was the first widely used antibiotic?
- a. Erythromycin.
 - b. Sulfisoxazole.
 - c. Cephalexin.
 - d. Penicillin.
74. (033) Bacteria whose gram-stain cannot be removed by using alcohol or other solvents are said to be
- a. Acid-fast.
 - b. Gram-fast.
 - c. Gram-positive.
 - d. Gram-negative.
75. (033) What type of bacteria grow best in the absence of oxygen?
- a. Aerobic.
 - b. Anaerobic.
 - c. Microaerophilic.
 - d. Facultative anaerobes.

Student Notes

CDC 4P051B

Pharmacy Journeyman

Supplementary Material for Volumes 1, 2, 3, and 4

Glossary



Extension Course Institute

Air University

Air Education and Training Command

Glossary of Terms

Accreditation	The process by which an agency or organization evaluates and recognizes a program of study or an institution as meeting predetermined qualifications.
Achlorhydria	Absence of hydrochloric acid in the stomach.
Active transport	Movement of drug molecules against a concentration gradient, i.e., from an area of low concentration to an area of higher concentration.
Acute illness	An illness with severe symptoms and of short duration.
Administer	Give a patient medication, once it is checked for accuracy.
Administration (or route of administration)	Refers to how a drug or therapy is introduced into the body. Systemic administration means that the drug goes throughout the body (usually carried in the bloodstream), and includes oral administration (by mouth) and intravenous administration (injection into the vein). Local administration means that the drug is applied or introduced into a specific area affected by disease, e.g., application directly onto the affected skin surface (topical administration). The effects of most therapies depend upon the ability of the drug to reach the affected area, thus the route of administration and consequent distribution of a drug in the body is an important determinant of its effectiveness.
Admixture	Term used to denote one or more active ingredients in a large-volume parenteral solution.
Adverse drug reaction	Any unexpected, obvious change in a patient's condition that the physician suspects may be due to a drug.
Aerosol	Finely nebulized medication for inhalation therapy.
Aerosolization	Producing an aerosol.
Alkaloid	A nitrogenous basic substance found in plants or synthetic substances with structures similar to plant structures, e.g., atropine, caffeine, morphine.
Allergy	A disorder in which the body becomes hypersensitive to a particular antigen (called an allergen).
Allopathy	Treatment of diseases with drugs that cause the opposite effect, e.g., antipyretics to reduce fever.
Ambulatory care	Care provided to persons who do not require either an acute (hospital) or chronic care (skilled nursing facility) setting.

American Society of Health-System Pharmacists (ASHP)	A national organization established in 1942. Includes pharmacists in various institutional health care settings. Presently contains a section for pharmacy technicians.
Aminoglycosides	A chemical compound that is present in a number of antibiotics, some of which are derived from microorganisms while others are produced synthetically.
Ampule	A small glass container that can be sealed and its contents sterilized. This is a French invention for containing hypodermic solutions.
Analgesic	An agent that relieves pain without causing loss of consciousness, e.g., codeine.
Angina pectoris	Severe pain and a sensation of constriction about the heart. The condition is caused by a relative deficiency of oxygen supply to the heart muscle.
Angiotensin-converting enzyme (ACE)	Helps inhibit the renal mechanism for blood elevation.
Anhydrous	Containing no water.
Anionic	Carrying a negative charge.
Antagonist	A drug that opposes the action of another drug or natural body chemical.
Antianginal	An agent used to treat angina pectoris. During attack, patient inhales amyl nitrate or uses nitroglycerin sublingually. Nitroglycerin may be administered using transdermal patches. Beta blocking drugs, such as propranolol, are effective in treating angina but their side effects may make it necessary to discontinue the drug. Calcium channel blockers such as nifedipine, verapamil, or diltiazem are used in treating angina.
Antiarrhythmic	An agent that restores normal heart rhythm.
Antibiotic	A medication that is derived from living cells or synthetic compounds and is antagonistic to other forms of life, especially bacteria; a soluble substance derived from a mold or bacterium that inhibits the growth of other organisms and is used to combat disease and infection.
Anticholinergic	A drug that blocks the passage of impulses through parasympathetic nerve fibers.
Antidote	A remedy for counteracting a poison.

Antiemetics	An agent that prevents or relieves nausea and vomiting.
Antifungal	An agent that destroys or inhibits the growth of fungi.
Antihypertensive	An agent that reduces blood pressure.
Antimicrobial	An agent that destroys or prevents the development of microorganisms.
Antineoplastic agent	An agent that prevents the development, growth, or proliferation of malignant cells. Chemotherapy agent or cancer drug.
Antiseptic	A substance used to destroy pathogenic organisms.
Antitussive	An agent that prevents or relieves coughing. Central acting antitussives are agents that depress the medullary centers, thus suppressing the cough reflex.
Antiviral	Opposing the action of a virus.
Apothecary	Early American or European term for a pharmacist.
Apparent volume of distribution	The apparent volume of plasma that would be required to account for all the drug(s) in the body; rarely corresponds to a real volume space in the body.
Arrhythmia	Any deviation from normal heartbeat.
Arteriosclerosis	Disorder characterized by thickening, loss of elasticity, and calcification of the walls of the arteries.
Arthroscope	An endoscope for examining the interior of a joint.
Aseptic	A condition in which there are no living microorganisms; free from infection.
Bacteriostatic	Inhibiting the growth of bacteria.
Backup systems	Alternate procedures in the event a computer system should fail.
Bar coding	A series of vertical bars and spaces of varying thickness and heights to represent information.
Basicity	The power of an acid to react with bases, dependent on the number of replaceable hydrogen atoms of the acid.
Beta blocker	A drug that selectively blocks beta receptors in the autonomic nervous system.
Bile	A fluid secreted by the liver.
Bile salts	Naturally occurring surface active agents secreted by the gall bladder into the small intestine.

Bioavailability	The rate and extent to which an active drug or metabolite enters the general circulation, thereby permitting access to the site of action. Bioavailability is determined either by measuring the concentration of a drug in body fluids or by the magnitude of the pharmaceutical response.
Biodegradable	Can be broken down by living organisms.
Bioengineered therapies	The process used in the manufacture of therapeutic agents through recombinant DNA (deoxyribonucleic acid) technology.
Bioequivalent	The property of having the same biological effects of that to which a medicine was compared.
Biological equivalents	Those chemical equivalents that, when administered in the same amounts, provide the same biological or physiological availability.
Biological fluids	Includes blood, serum, plasma, lymph, etc.
Biologicals	General term applied to medicinal compounds that are prepared from living organisms and their products. Includes serums, vaccines, antigens, and antitoxins.
Biopharmaceutics	The branch of pharmaceutics that concerns itself with the relationship between physiochemical properties of a drug in a dosage form, and the pharmacologic, toxicologic, or clinical responses observed after drug administration.
Biotechnology	The application of biological systems and organisms to technical and industrial processes.
Biotransformation	The chemical alterations that a substance undergoes in the body.
Blending	Mixing.
Blister packages	Cardboard and plastic material that is heat-sealed to individually package medication.
Botany	The science of plants, including structure, functions of parts, and classification.
Brand name drugs	Drugs that are research-developed, patented, manufactured, and distributed by a drug firm.
Buccal	Relating to the cheek. A buccal medicine is taken by placing it in the cheek pocket and letting it slowly dissolve.
Budget	The projected costs allocated on a yearly basis for personnel, supplies, construction, and operating expenses.
Buffer	Offers a resistance to pH change.

Candida	A yeast organism that normally lives in the intestines but can flourish in other parts of the body at times of immune suppression.
Caplet	A tablet shaped like a capsule.
Capsule	A soluble container enclosing medicine.
Cardiotonic	An agent that has the effect of producing or restoring normal heart activity.
Carminative	A medicine that relieves stomach/intestinal gas.
Cataract	Loss of transparency of the lens of the eye.
Cathartic	An agent that causes bowel evacuation.
Catheter	A tubular device used for the drainage or injection of fluids through a body passage. Catheters are made of silicone, rubber, plastic, or other materials.
Cationic	Carrying a positive charge.
Central processing unit (CPU)	The unit of a computer that accomplishes the processing or execution of given calculations or instructions.
Centralized system	A system of distribution in which all functions, processing, preparation, and distribution occur in a main area, e.g., the main pharmacy.
Chemical equivalents	Those multiple-source drug products that contain identical amounts of the identical active ingredient in identical dosage forms.
Chemotherapy	The treatment of an illness with chemicals; commonly refers to the treatment of malignancy with agents that are cytotoxic, i.e., a medication that kills cells; more specifically, use of chemicals to treat cancer.
Cholinergic	A drug that is stimulated, activated, or transmitted by acetylcholine.
Chronic illness	A disturbance in health that persists for a long time, usually one showing little change or slow progression over time.
Clinical	Involving direct observation of the patient.
Clinical pharmacokinetics	That branch of pharmaceuticals that deals with the application of pharmacokinetics to the safe and effective therapeutic management of a patient.
Clinical pharmacy	Patient-oriented pharmacy practice that is concerned with health care through rational drug use.

Clinical pharmacy practice	The application of knowledge about drugs and drug therapy to the care and treatment of patients.
Commission on credentialing	The body appointed to formulate and recommend standards and administer programs for accreditation of pharmacy personnel training programs.
Computer	A programmable electronic device used to store, process, or communicate information.
Computer system	A combination of hardware and software working together to perform specific functions.
Conjunctiva	Delicate mucous membrane covering the front of the eye and the inside of the eyelid.
Contaminated	Unclean; microorganisms introduced into an area where they had not previously been present.
Contraindicate	To indicate against; to indicate the inappropriateness of a form of treatment or a drug for a specific disease.
Control	Any method used to eliminate or reduce the potential harm of the medication distributed.
Control documents	Forms, such as records, sheets, logs, or checklists, that track conformance with established standards in order to reduce the likelihood of an error or negative outcome.
Controlled substances	Drugs controlled by the federal and/or state Drug Enforcement Administration which can produce dependence or be abused, e.g., narcotics, select psychotropics, steroids, etc.
Controlled Substances Act	Federal law regulating the manufacture, distribution, and sale of drugs that have the potential for abuse.
Counter balance	A double-pan balance capable of weighing relatively large quantities.
Counterirritant	An agent, such as mustard plaster, that is applied locally to produce an inflammatory reaction for the purpose of affecting some other part of the body, usually adjacent to or underlying the surface irritated.
Cream	Water-based semisolid external dosage form.
Criteria	A set of statements that define quality.
Cytotoxics	Chemical agents that kill cells or stop cell division.
Data entry	The input function that involves recording, coding, or converting data to a form that a computer can recognize.

Decentralized system	A system of distribution where all functions (processing, preparation, and distribution) occur on or near the nursing unit, e.g., satellite pharmacy.
Deionized	Ions have been removed from a substance, thus producing a substance free of minerals.
Density	Weight per unit volume.
Dermatological	Referring to the skin and its diseases.
Dextran	A polysaccharide. It is available in various molecular weights and is used as a plasma volume expander.
Diabetes mellitus	A metabolic disorder in which fault pancreatic activity decreases the oxidation of carbohydrates.
Diagnosis	The determination of the nature of a disease or symptom through physical examination and clinical testing.
Diagnostic equipment	Articles or implements used to detect physical conditions that may be related to disease or biological changes; usually used at home by one patient.
Didactic instruction	Formalized, structured, lecture-type education program.
Diluent	An agent that dilutes the substance or solution to which it is added.
Disinfectant	A substance used to destroy pathogens; generally used on objects rather than on humans.
Dispensing	The process of preparing, checking, and delivering prescribed medication and associated information. This process must be under the supervision of a pharmacist.
Dissolution	The act of dissolving.
Diuresis	Increased excretion of urine.
Diuretic	An agent that causes an increase in the excretion of urine.
Dosage	The determination and regulation of the size, frequency, and number of doses.
Dosage forms	The various pharmaceutical forms whereby drugs are made available, e.g., capsules, patches, injections, etc.
Dosage schedule	The frequency, interval, and length of time a medicine is to be given.
Dosage strength	The quantity of a drug in a given dosage form.
Dose	A quantity of a drug or radiation to be given at one time.
Drug	Any substance to treat or prevent disease.

Drug disposition	All processes that occur to a drug after absorption and that can be subdivided into distribution and elimination.
Drug distribution	The process of reversible transfer of a drug to and from the site of measurement, usually the blood.
Drug elimination	The irreversible loss of a drug from the site of measurement, usually subdivided into metabolism and/or excretion.
Drug formulary	A list of medicinal agents, selected by the medical staff, considered to be the most useful in patient care.
Drug information	Information about drugs and the effects of drugs on people, the provision of which is a part of each pharmacy's practice.
Drug label	Information placed on a drug container that includes data required by drug regulations.
Drug misadventures	What can go wrong in the "therapeutic adventure" of using a medication. Drug misadventures encompass errors in prescribing judgment, system errors in the process of bringing drug products to the ultimate users, and idiosyncratic (individual and unusual sensitivity that is not dose-related) responses to medication.
Drug order	A course of medication therapy ordered by the prescriber in an organized health care setting.
Drug recalls	Voluntary recall of a drug because of a health hazard potential.
Drug regimen review	Process to provide appropriate drug therapy for patients as part of the health care team.
Drugs of choice	The preferred or best drug therapy that can be prescribed for a specific disease state, based upon majority medical opinion.
Drug-use control	The system of knowledge, understanding, judgments, procedures, skills, controls, and ethics that assures optimal safety in the distribution and use of medication.
Drug-use process	The series of steps necessary to move a drug product from purchase to patient use.
Duodenum	That area of the small intestine that is the first 25 cm after the stomach; responsible for significant drug absorption.
Dyscrasias	Diseases.
Elastomer	An elastic-type substance.
Electrolytes	Naturally occurring ions in the body that play an essential role in cellular function, in maintaining fluid balance, and in establishing acid-base balance; an ionizable substance in solution, e.g., sodium, potassium chloride.

Electronic mail	A form of transmitting, storing, and distributing text in electronic form via a communications network.
Emesis	Clinical term for vomiting.
Emetic	An agent that causes vomiting.
Emulsifying agent	A substance used in preparing an emulsion.
Endogenously	Originating within the organism.
Endophthalmitis	Inflammation of the inside of the eye that may or may not be limited to a particular chamber.
Enteral	Within or by way of the intestine.
Enteric coated tablet	A special tablet coating that prevents the release of a drug until it enters the intestine.
Enterohepatic cycling	Drug taken up by the bile, secreted into the small intestine, and may be reabsorbed back to the blood.
Epidemic	A disease that attacks many people in the same region at the same time.
Etiology	The study of all the factors that may be involved in the development of disease.
Excipients	Pharmacologically inert, adhesive substances such as honey, syrup, or gum arabic used to bind the contents of a pill or tablet.
Excretion	The process whereby the undigested residue of food and the waste products of metabolism are eliminated.
Expectorant	A substance that promotes the ejection of mucus or an exudate from the lungs, bronchi, and trachea.
Extemporaneous	Prepared at the time it is required, with materials on hand.
Extended release capsules/tablets	Capsules or tablets that are formulated in such a way as to gradually release a drug over a predetermined time period.
Extraocular	Outside the eye.
Extravasation	The escape of fluids into the surrounding tissue.
Federal Food, Drug and Cosmetic Act	The federal statute through which the Food and Drug Administration (FDA) promulgates its rules and regulations.
First pass effect	Metabolism of a drug by the gut or liver after oral absorption but before the drug has made one pass through the systemic circulation.
Fluid extract	A liquid preparation of a herb containing alcohol as a solvent or preservative.

Floor stock	Medications provided to the nursing unit for administration to the patient by the nurse. The nurse is responsible for preparation and administration.
Food and Drug Administration (FDA)	Promulgates rules and regulations to ensure public safety regarding drug products.
Galenical	A standard preparation containing one or several organic ingredients, e.g., elixir.
Gargle	A substance used to rinse or medicate the mucous membrane of the throat and mouth.
Generic drugs	Drugs labeled by their “official” name and manufactured by a drug firm after the original patent expires.
Genotoxic	Toxic to the genetic material in cells.
Glycoside	Compound containing a sugar molecule, e.g., digitalis.
Gluteal	Pertaining to the buttocks.
Habituation	Acquired tolerance for a drug.
Health care delivery	Organized programs developed to provide physical, mental, and emotional health care in institutions for home-bound and ambulatory patients.
Health maintenance organization (HMO)	A prepaid health insurance plan that provides comprehensive health care for subscribers, with emphasis on the prevention and early detection of disease and continuity of care. HMOs are either not-for-profit or for-profit, are designated as either an independent practice association (IPA) or a staff model, and are often owned and operated by insurance carriers. HMOs were developed as a means to control health care delivery, access, and cost.
Hemodialysis	Procedure by which impurities or wastes are removed from the blood.
Hemolysis	The destruction of red blood cells with the liberation of hemoglobin, which diffuses into the surrounding fluid.
Herb	A leafy plant used as a healing remedy or a flavoring agent.
Heterogeneous	Of unlike natures; composed of unlike substances. Opposite of homogeneous.
High efficiency particulate air (HEPA)	Used in laminar flow hoods.

Homeostasis	A tendency toward stability in the internal body environment; a state of equilibrium.
Homogeneous	Uniform in structure, composition, or nature. Opposite of heterogeneous.
Hormone	A chemical substance, produced by cells or an organ, that has a specific regulatory effect in the body.
Hospital	A network of health care services for treatment, care of the sick, study of disease, therapy, and the training of health care professionals.
Hospital information systems (HIS)	Systems that integrate information from many parts of the hospital.
Humor	A fluid or semifluid substance in the body; originally phlegm, blood, or bile, for example, aqueous humor is the fluid produced in the eye (not tears).
Hydroalcoholic	Mixture of water and alcohol.
Hydrolysis	Any reaction in which water is one of the reactants.
Hydrophilic	Water-loving.
Hydrophilic drug molecules	Drug molecules that are polar and water-loving.
Hydrophobic drugs	Drugs whose molecules are nonpolar and lipid-loving or water-hating.
Hygroscopic	Absorbing moisture readily.
Hyperalimentation	The enteral and parenteral infusion of a solution that contains sufficient amino acids, glucose (dextrose), fatty acids, electrolytes, vitamins, and minerals to sustain life, maintain normal growth and development, and provide for needed tissue repair. Also known as TPN (total parenteral nutrition).
Hypersensitivity	Excessive response of the immune system to a sensitizing antigen.
Hypertension	Also called “high blood pressure.” Blood pressure (in the arteries/ blood vessels) that is higher than normal for the patient’s age group. Hypertension often shows no outward signs or symptoms but may lead to a number of serious health problems.
Hypertonic	Having a higher osmotic pressure than a compared solution. Pertaining to a solution of higher osmotic pressure than another.

Hypoglycemic agent	A drug that lowers the level of glucose in the blood; used primarily by diabetics.
Hypolipodemic agent	An agent to reduce lipids (fat) in the blood.
Hypometabolic	Low basic metabolic rate.
Hypotonic	A solution of lower osmotic pressure than that of a reference solution or of an isotonic solution.
Ideal drug therapy	Safe, effective, timely, and cost-conscious medication use.
Immiscible	Pertaining to that which cannot be mixed, as oil and water.
Immunity	The condition of being resistant to a particular disease, e.g., polio.
Immunomodulators	Agents that adjust the immune system to a desired level.
Immunosuppressant	Medicine that reduces the body's natural immunity.
Incompatibility	Lack of compatibility; an undesirable effect when two or more substances are mixed together.
Inert	Not active; sluggish. In chemistry, having little or no tendency or ability to react with other chemicals.
Infection	The state or condition in which the body (or part of it) is invaded by an agent (microorganism or virus) that multiplies and produces an injurious effect (active infection).
Infection control	The use of appropriate procedures and education to minimize the transfer of infections from one to another.
Infusion	The introduction of a solution into a vein by gravity or by an infusion control device or a pump.
Injection	The introduction of a fluid substance into the body by means of a needle and syringe.
Inoculum	Microorganism or other material introduced into a system.
Input devices	Include keyboards, light pens, optical scanners, bar code readers.
Institutional pharmacy	Pharmacy services provided in hospitals, nursing homes, health maintenance organizations, prisons, mental retardation facilities, or other settings wherein groups of patients are provided formal, structured pharmacy programs.
Intoxication	State of being poisoned by a drug or being inebriated with alcohol.
Intraocular	Within the eyeball.
Intravenous (IV)	Within a vein; administering drugs or fluids directly into the vein to obtain a fast or complete effect from the drug.

Intravitreal	Pertaining to the vitreous of the eye.
Inventory	A complete listing of the exact amounts of all the drugs in stock at a particular time.
Investigational drugs	Drugs that have not received approval for marketing by the Food and Drug Administration.
Iontophoresis	Use of an electric current to cause an ionized drug to pass through the skin into the system circulation.
Isotonic	Having the osmotic pressure.
Isotonicity	The state or condition of being isotonic.
Keratitis	Inflammation of the cornea, with is usually associated with decreased visual acuity.
Lacrimal	Pertaining to tears.
Lacrimal fluids	Tears.
Leaching	Effect of removing a soluble substance from a solution.
Levigation	Mixing of particles with a base vehicle, in which they are insoluble, to produce a smooth dispersion of the drug by rubbing with a spatula on a tile.
Lipophil	Absorbing fat or having an affinity for fat.
Lipophilic	Lipid loving.
Liposome	A small membrane that entraps and later releases an active ingredient.
Local area networks (LAN)	Permit different systems (mainframe, minicomputers, and microcomputers), as well as computers made by different manufacturers, to communicate and share data.
Long-term care	Health care provided in an organized medical facility for patients requiring chronic or extended treatment.
Long-term care facility	Facility for individuals who do not need hospital care but are in need of a wide range of medical, nursing, and related health and social services.
Lotions	Liquid preparations intended for external application.
Luer-lok syringe	A syringe made to permit rapid and firm attachment of a needle.
Mainframe	The largest, most powerful type of computer system; is able to service many users at once and process several programs simultaneously; has large primary and secondary storage capacities.

Malaria	An infectious fever-producing disease transmitted by infected mosquitoes.
<i>Materia medica</i>	The branch of pharmacy that deals with drugs and their source, preparation, and use.
Materials management	The division of a hospital pharmacy responsible for the procurement, control, storage, and distribution of drugs and pharmaceutical products.
Matrix management	An organizational concept that emphasizes the interrelationship between departments and the common area of decision making.
Medication administration record (MAR)	The document used by the nursing department to chart the medication administered to a patient.
Medium	Solvent used in dissolution testing.
Meniscus	The outer surface of a liquid having a concave or crescent shape caused by surface tension.
Metabolism	The conversion of one chemical specified to another in the body.
Micronized drug particles	Very small drug particles that have a diameter in the smallest size range.
Microorganism	A microscopic plant or animal.
Milling	Reducing the particle size.
Minicomputer, microcomputer, or personal computer system	System used for well-defined and specialized applications.
Mnemonic codes	Short entries that are easy to remember and represent a longer instruction used to assist in the entry of data.
Moiety	A part of a molecule that exhibits a particular set of chemical and pharmacologic characteristics.
Mucosa	A mucous membrane or the moist tissue layer that lines a hollow organ or body cavity.
Mutagen	An agent that causes genetic mutations. Many medicines, chemicals, and physical agents such as ionizing radiations and ultraviolet light have this ability.
Narcotic antagonists	Agents that oppose or overcome the effects of a narcotic.

Nasogastric tube	A tube that is inserted though the nose, down the throat, and into the stomach so that medicine, food, or nutrients may be administered to patients who cannot swallow.
Nasolacrimal	Pertaining to the nose and lacrimal apparatus.
Nebulizer	Instrument that applies liquid in the form of a fine spray.
Negligence	Breach of an ordinary duty of care that is owed by one person to another.
Nomogram	Representation, by graphs, diagrams, or charts, of the relationship between numerical variables.
Nosocomial	A disease or infection originating in the hospital.
Objective	The purpose or goal toward which effort is directed.
Ointment	Oil-based, semisolid, external dosage form, usually containing a medicine substance.
Oleaginous	Resembling or having the properties of oil.
Oncogenic	Giving rise to tumors, especially malignant tumors.
Oncology	The study or knowledge of tumors; commonly refers to the study of cancer and related diseases.
One-compartment model	The simplest case in pharmacokinetics in which the body is thought to behave as a single homogeneous compartment.
Operation manual	Lists only those policies and procedures that affect the internal working of the pharmacy department.
Osteoporosis	Disorder characterized by abnormal porosity of bone, usually in older women.
Outcome competency	The measurable, desired ability, knowledge, and skill achieved upon completion of a program.
Output devices	Include video display terminals (CDT), cathode ray tubes (CRT), printers, and plotters.
Otic	Relating to the ear.
Pandemic	A global epidemic disease.
Parenteral	(1) Denoting any medication route other than the alimentary canal, such as intravenous, subcutaneous, intramuscular, or mucosal. (2) A sterile, injectable medication; introduction of a drug or nutrient into a vein, a muscle, subcutaneous tissue, an artery, or the spinal column; often refers to intravenous infusions of nutritional solutions.

Passive diffusion	Movement of drug molecules from an area of high concentration to one of a lower concentration.
Pathology	Study of characteristics, causes, and effects of disease.
Patient package insert	An informational leaflet written for the lay public describing the benefits and risks of medications.
Patient profile	A document that is used to incorporate patient information, allergies, sensitivities, and all medications the patient is receiving, both active and discontinued.
Patient's Bill of Rights	A declaration ensuring that all patients (inpatients, outpatients, and emergency service patients) are afforded their rights in a health care institution.
Peptides	A compound of two or more amino acids.
Percutaneous	Through the skin.
Periocular	Located around the eye.
Peripheral devices	Send information to a computer for processing and receive information from the CPU once the data has been processed.
Pharmaceutical alternatives	Drug products that contain the same therapeutic moiety and strength but differ in the salt, ester, or dosage form.
Pharmaceutical care	The responsible provision of drug therapy to achieve definite outcomes that improve a patient's quality of life.
Pharmaceutical services	Focus on rational drug therapy; includes the essential administrative, clinical, and technical functions to meet this goal.
Pharmaceutics	That part of the pharmaceutical sciences that deals with the chemical, physical, and physiological properties of drugs, dosage forms, and drug-delivery systems.
Pharmacist	A person who has (1) completed five, six, or seven years of formal education in a pharmacy school, and (2) is licensed to prepare and distribute drugs and counsel on the use of medication in the state in which he or she practices.
Pharmacognosy	The study of the biologic and biochemical features of natural drugs.
Pharmacokinetics	Study of the metabolism and action of drugs with particular emphasis on the time required for absorption, duration of action, distribution in the body, and method of excretion.
Pharmacology	The science that deals with the origin, nature, chemistry, effects, and uses of drugs.

Pharmacopoeia	An authoritative treatise on drugs and their purity, preparation, and standards.
Pharmacotherapy	Use of medicine in treatment of disease.
Pharmacy	The professional practice of discovering, preparing, dispensing, monitoring, and educating about drugs.
Pharmacy mission	To help people make the best use of medication.
Pharmacy service	(1) The procurement, distribution, and control of all pharmaceuticals used within the facility; (2) the evaluation and dissemination of comprehensive information about drugs and their use; and (3) the monitoring, evaluation, and assurance of the quality of drug use.
Phlebitis	Inflammation of a vein.
Phlegm	Viscous mucus secreted orally.
Physician	An authorized practitioner of medicine.
Physician assistant	An authorized practitioner of medicine who works under the responsible supervision of a licensed physician.
Piggyback	Refers to small-volume IV solution (25–250 mL) that is run into an existing IV line over a brief period of time, e.g., 50 mL over fifteen minutes.
Pill	A small globular or oval medicated mass intended for oral administration.
Pipette	Narrow glass tube with both ends open for transferring and measuring liquids by sucking them into the tube.
Pneumatic tube	A method of sending medication orders through the hospital by placing it in a “tube” and sending it to a dispatcher who then forwards it to a specific location.
Podiatrist	A specialist in foot care.
Poison Prevention Packaging Act	Federal law mandating special packaging requirements that make it difficult for children under the age of five to open a package or container.
Policy	A defined course to guide and determine present and future decisions; established by an organization or employer that guide the employee to act in a manner consistent with management philosophy.
Polymer	A high-molecular-weight substance made up of identical base units.

Polymorphic state	A condition in which a substance occurs in more than one crystalline form.
Polyurethanes	Substances sometimes used for linkage in elastomers.
Postoperatively	Following surgical operation.
Preferred provider organization (PPO)	An insurance plan that provides comprehensive health care through contracted providers.
Preferred vendor	The drug firm selected as the wholesaler.
Prescriber	A person in health care who is permitted by law to order drugs that legally require a prescription; includes physicians, physician assistants, podiatrists, dentists, and nurse practitioners.
Prescription	Permission granted orally or in writing from a prescriber for a patient to receive a certain medication on an outpatient basis that will help relieve or eliminate the patient's problem.
Preservatives	Substances used to prevent the growth of microorganisms.
Prime vendor	Drug wholesaler who contracts directly with hospital pharmacies for the purpose of their high-volume pharmaceuticals.
Procedures	Guidelines on the preferred way to perform a certain function; particular actions to be taken to carry out a policy.
Product line management	An organization concept that emphasizes the end product or category of services being delivered.
Programs	Instructions for a computer.
Propellant	A substance used to help expel the contents of a pressurized container.
Prophylaxis	Prevention of or protection against disease.
Pro res natum (PRN)	Drug to be given as needed when a clinical situation arises.
Proteins	Macromolecules consisting of amino acids.
Psychiatric	Relating to the medical treatment of mental disorders.
Psychotropic	A drug used to treat mental and emotional disorders.
Purified protein derivative (PPD)	Skin test for tuberculosis.
Pyrogen	Any substance that produces fever.
Quality assurance	A method of monitoring actual versus desired results in an effort to assure a certain level of quality that meets predetermined criteria.

Quality assurance program	A format that elaborates special basic quality assurance steps.
Quality of life	A meaningful life for the patient at the optimum level of functioning for as long as possible.
Quality standards	The minimum results needed to achieve a desired level of quality.
Radiopaque	Having the property of absorbing x-rays.
Reconstitute	Adding a sterile solvent to a sterile active ingredient for injectable purposes. This procedure can also be used for oral purposes.
Rectal	Relating to the rectum.
Refractory	Unresponsive.
Retrobulbar	Behind the eyeball.
Rule of three	The process of pharmacy personnel checking a medication being prepared and dispensed three times before it is administered to a patient.
Satellite pharmacy	Where distribution occurs from a decentralized pharmacy. A satellite usually handles all the needs of the units or sections for which it is responsible.
Scanners	Optical recognition devices that read preprinted characters or codes.
Secondary storage	Data and programs maintained on tapes or discs.
Semipermeable	Half permeable; said of a membrane that will allow fluids, but not the dissolved substance, to pass through it.
Sepsis	Presence of pathogenic organisms in the blood.
Soft copy	Visual display units.
Software	The actual programs for a computer system.
Solution	A homogeneous mixture of one or more substances dispersed in a dissolving solvent; clear liquid with all components completely dissolved.
Solution balance	Single unequal arm balance used for weighing large amounts.
Solvate	A compound formed by the reaction between a solvent and solute.
Solvation	Process by which a solute is incorporated into a solvent.
Stability	A condition that resists change; for example, a drug maintains potency.

Standard	A reference to be used in evaluating institutional programs and services.
Standard of care	The acceptable level of professional practice that exists by which the actions of a professional are judged.
Standards of practice	Rules that are established for a profession that represent the preferred way to practice.
Staphylococcus (plural staphylococci)	Microorganism of the family <i>micrococcaceae</i> that is the most common cause of localized suppurative infections.
Sterile	Free from microorganisms.
Stop order	Stop medication. An automatic stop order requires a prescriber's renewal order or the medication should be discontinued.
Subconjunctival	Beneath the conjunctiva.
Subcutaneously	Under the skin; introduced beneath the skin (e.g., subcutaneous injections).
Sudorific	A substance that causes sweating; also called a <i>diaphoretic</i> .
Suppositories	Solid dosage forms for insertion into body cavities (e.g., rectum, vagina, urethra) where they melt at body temperature.
Surface active agents	Substances that lower the surface tension of liquids.
Surfactants	Surface active agents, commonly known as wetting agents.
Suspension	Liquid containing finely divided drug particles uniformly distributed.
Synthesize	Combining elements to form a chemical compound.
Syrup	A concentrated sugar solution that may have an added medicinal.
System software	Contains the operating system that includes master programs for coordinating the activities of the hardware and software in a computer system.
Systemic	Pertaining to a whole body rather than to one of its parts or organs.
Systemic side effect	An effect on the whole body, but secondary to the intended effect.
Tablet	A solid dosage form of varying weight, size, and shape that contains a medicinal substance.
Tare	A weight used to counterbalance the container holding the substance being weighed.
Teratogenic	Substance that interferes with normal prenatal development.

Therapeutic	Provision of treatment of a disease, infirmity, or symptom by various methods.
Therapeutic alternates	Drug products that contain different therapeutic moieties but that are of the same pharmacologic and/or therapeutic class.
Therapeutic effect	A healing, curative, or ameliorating effect.
Therapeutic equivalent	A drug product that, when administered in the same amount, provides the same therapeutic effect and pharmacokinetic characteristics as another drug to which it is compared.
Therapeutic substitution	The substitution of one drug product with another that differs in composition but is considered to have the same or very similar pharmacologic and therapeutic activity.
Therapy	Treatment of disease.
Tincture	An alcoholic or hydroalcoholic solution containing a medicinal substance.
Tonicity	State of normal tension or partial contraction of muscle fibers while at rest.
Topical	Pertaining to the surface of a part of the body.
Total parenteral nutrition (TPN)	Intravenous nutrition comprised of any or all of the following: amino acids, dextrose, lipids, vitamins, minerals, trace elements, electrolytes, and water in a prepared sterile solution that infuses into a large central venous blood vessel. TPN provides all of the essential nutrients needed for patients to survive if they are unable to ingest nutrients.
Toxic effect	Acute or chronic poisoning through use of pharmaceuticals.
Toxicity	Degree to which something is poisonous.
Toxicology	The scientific study of poisons and their actions, detection, and treatment of conditions caused by them.
Toxin	A poison.
Transdermal	Entering through the dermis or skin, as in administration of a drug applied to the skin in ointment or patch form.
Triturate	To reduce particle size and mix one powder with another.
Troche	A small tablet intended to dissolve in the mouth to deliver medication to the mouth or throat.
Unit dose	A single-use package of a drug. In a unit-dose distribution system, a single dose of each medication is dispensed prior to the time of administration.

Urethra	Tube through which urine passes from the bladder to the outside of the body.
Utilization review	Work of committee that determines how use of resources meets criteria and standards.
Vaccination	Introduction of a vaccine into the body to produce immunity to a particular disease, e.g., smallpox inoculation.
Vaccine	A suspension of attenuated or killed bacteria, viruses, or rickettsiae administered for the prevention, amelioration, or treatment of infectious diseases, e.g., tetanus.
Vasoconstrictor	A process, drug, or substance that causes constriction of blood vessels.
Vasodilator	An agent or drug that causes dilation of the blood vessels; increases the caliber of the blood vessels.
Verified	Reviewed and approved as true and authentic.
Vertical laminar flow hood	An air filter process to maintain a particulate-free environment.
Volatile	Evaporates at low temperature.

Glossary of Abbreviations and Acronyms

ACE	Angiotensin-converting enzyme
ADJ	CHCS menu code option for adjustments to inventory
AFMLL	Air Force Medical Logistics Letter
AFMLO	Air Force Medical Logistics Office
AFOSH	Air Force Occupational Safety and Health
AFS	Air Force specialty
AFSC	Air Force specialty code
AHFS	American Hospital Formulary Service
AIDS	Acquired immune deficiency syndrome
ALS	Advanced life support
AMH	<i>Accreditation Manual for Hospitals</i>
APhA	The American Pharmaceutical Association
ASHP	American Society Of Health-system Pharmacists
BCA	Business case analysis
BCM	CHCS menu code option for baker cell menu
BLMPS	Base level military personnel system
BLS	Basic life support
BMET	Biomedical equipment technician
BSC	Biomedical Science Corps
CCAF	Community College of the Air Force
CCM	Cost center manager
CDT	Video display terminal
CEM	Chief enlisted manager
CFG	CHCS menu code option for create formulary group
CHAMPUS	Civilian Health and Medical Program of the Uniformed Services
CHCS	Composite Healthcare System
CIR	CHCS menu code option for create inventory record
CLEP	College level examination program
CNM	Certified nurse midwife

CNV	CHCS menu code option for cancel a non-verified issue
COM	CHCS menu code option for complex ivf recipe create
CONUS	Continental United States
COS	CHCS menu code option for create/edit order sets
CPD	Central processing and distribution
CPM	CHCS menu code option for controlled prescription menu
CPSC	Consumer Product Safety Commission
CPU	Central processing unit
CRIS®	Controlled-release infusion system
CRNA	Certified registered nurse anesthetist
CRT	Cathode-ray tube
CSA	Controlled Substances Act
DANTES	Defense Activity for Nontraditional Education Support
DAPA	Distribution and pricing agreement
DAW	Dispense as written
DBOF	Defense business operations fund
DBPA	Decentralized blanket purchase agreement
DCI	CHCS menu code option for decrement from controlled inventory
DEA	Drug Enforcement Agency
DLA	Defense Logistics Agency
DLS	CHCS menu code option for define location served
DML	Director of Medical Logistics
DMLSS	Defense Medical Logistics Standard Support
DoD	Department Of Defense
DPSC	Defense Personnel Support Center
DRMO	Defense Re-Utilization and Marketing Office
DRU	Direct reporting unit
DUR	Drug utilization review
EAL	Entry authorization list
EAS	Expense assignment system
ECD	Estimated completion date

EDC	CHCS menu code option for enable/disable baker cell
EMC	Emergency message change
EML	CHCS menu code option for edit user options
Eq	Equivalent
ERAA	Equipment review and authorization
ERV	Estimated return value
EXP	CHCS menu code option for enter expiration/receiver of issue
FDA	Food and Drug Administration
FMP	Family member prefix
FOA	Field Operating Agency
FOM	CHCS menu code option for formulary menu
FRM	Chcs menu code option for formulary maintenance
FSS	Federal Supply Schedules
FTE	Full time equivalent
GITS	Gastrointestinal therapeutic system
GML	CHCS menu code option for group membership
gr	Grain
gtt	Drop
GYN	Gynecology
HCFA	Health Care Financing Administration
HCM	CHCS menu code option for healthcare provider maintenance
HCP	Health care provider
HEPA	High efficiency particulate air
HIV	Human immunodeficiency virus
HML	CHCS menu code option for help
HMO	Health Maintenance Organization
HSA	Hazardous Substance Act
HSI	Health services inspection
IAV	Inventory adjustment voucher
IDMT	Independent duty medical technician
IG	Inspector General

IM	Intramuscular
IMC	Interim Message Change
IV	Intravenous
IAW	In accordance with
IMPAC	International Merchant Purchase Authorization Card
INI	CHCS menu code option for inventory record inquiry
INV	CHCS menu code option for inventory supply menu
ISI	CHCS menu code option for issue inquiry
ISM	CHCS menu code option for issue menu
ISS	Information systems security
IVF	CHCS menu code option for iv medication profile
IVH	CHCS menu code option for IV hyperal
IVM	CHCS menu code option for IV file maintenance
IVP	CHCS menu code option for IV recipe create
JCAHO	Joint Commission on Accreditation of Healthcare Organizations
JQS	Job Qualification Standard
KVO	Keep vein open
LAN	Local area network
LBL	CHCS menu code option for reprint issue label
LGE	CHCS menu code option for location group edit
LNM	CHCS menu code option for list new messages
LOD	Line of duty
LVP	Large volume parenteral
MAJCOM	Major command
mcg	Microgram
mcl	Microliter
MDG	Medical group
MDOS	Medical operations squadron
MDS	Medical squadron
MDW	Medical wing
MDSS	Medical support squadron

MEB	Medical evaluation board
MEDCAT	Medical Catalog
MEDLOG	Medical Supply's Computerized Medical Logistics System
MEPRS	Medical Expense and Performance Reporting System
meq	Milliequivalent
MER	Medical equipment repair
MHCMIS	Military Health Care Medical Information System
MHSS	Military Health Services System
MMP	CHCS menu code option for minimum or maximum dose Parameters
MSDS	Material Safety Data Sheet
MTF	Medical treatment facility
MWR	Morale, Welfare, and Recreation
N.F.	<i>National Formulary</i>
NAR	CHCS menu code option for narcotic system maintenance menu
NDC	National Drug Code
NFPA	National Fire Protection Association
NKA	No known allergies
NML	CHCS menu code option for new messages and responses
NMS	Nutritional Medicine Service
NSD	CHCS menu code option for narcotic site definition
NSM	CHCS menu code option for narcotic system menu
NSN	National stock number
NUM	CHCS menu code option for prescription number maintenance
O&M	Operations and Maintenance
OB	Obstetrics
OBRA	Omnibus Budget Reconciliation Act
OEP	CHCS menu code option for stand-alone order entry Maintenance
OI	Operating Instruction
OLUM	CHCS menu code option for on-line users manual

OMG	Objective medical group
OMM	CHCS menu code option for outpatient maintenance menu
OPR	Office of primary responsibility or outpatient pharmacy reports
ORI	Operational readiness inspection
OSHA	Occupational Safety and Health Administration
OSI	Office of Special Investigations
OSR	Occupational survey report
OSU	CHCS menu code option for outpatient summary report
PA	Physician assistant
PC	Personal computer
PDO	Publication's Distribution Office
PDR	<i>Physician's Desk Reference</i>
P&T	Pharmacy and Therapeutics
PCM	Primary care manager
PCS	Permanent change of station
PDL	Preferred drug list
PEC	Pharmacoeconomic center
PIV	CHCS menu code option for site parameters (IV)
PME	Professional military education
PNM	CHCS menu code option for prescription number maintenance Menu
PPC	Product and price comparison
PPPA	Poison Prevention Packaging Act
PRM	CHCS menu code option for pharmacy reports menu
PRN	pro res natum; drug to be given as needed when a clinical situation arises
QAF	Quality Air Force
QAFA	Quality Air Force assessment
QML	CHCS menu code option for queued message for deletion
qs	Latin word meaning as much as suffices
RAI	CHCS menu code option for return an issue

RCRA	Resource Conservation and Recovery Act
REC	CHCS menu code option for recipe menu
REM	CHCS menu code option for remove Rx transaction
RES	CHCS menu code option for reset prescription numbers
RM	Resource Management
RML	CHCS menu code option for read a message
RMO	Resource management office
ROU	CHCS menu code option for medication routes
RRT	CHCS menu code option for return rx transaction
RTM	CHCS menu code option for record tracking menu
SAV	Staff assistance visit
SC	Subcutaneous
SGH	Chief of Hospital or Clinic Services
SII	Special interest item
SIM	CHCS menu code option for simple IVF recipe create
SKT	Specialty knowledge test
SML	CHCS menu code option for send a message
SOE	CHCS menu code option for stand-alone order entry maintenance menu
SQ or Sub-Q	Subcutaneous
ss	One-half
SSN	Social security number
stat	<i>Statim</i> , to be given immediately
ST	Sublingual tablet
STS	Specialty training standard
TASO	Terminal area security officer
TBC	CHCS menu code option for test the baker cell interface
TBS	Tablespoonful
tblsp	Tablespoonful
TDS	Transdermal delivery system
THREATCON	Terrorist threat condition

TIG	The Inspector General
TPN	Total parenteral nutrition
TSF	Tri-service formulary
UCA	Uniform Chart of Accounts
USP	United States Pharmacopoeia
UDF	CHCS menu code option for unit dose file maintenance menu
UDK	CHCS menu code option for use defined keys
UDS	CHCS menu code option for unit dose site parameters
UM	Utilization management
UPC	Uniform product code
UR	Utilization review
USM	Uniform staffing methodology
U.S.P.	<i>United States Pharmacopoeia</i>
VDT	Video display terminal
VER	CHCS menu code option for verified issues
VO	Voice order, verbal order
WAPS	Weighted Airman Promotion System
ZOP	Zero-overpricing

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Student Notes

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