Chapter 2

Diagnostics Terminology

Poked, prodded, and pictured

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Learning Outcomes

Level 1 **Know**	Define word parts and basic medical terminology related to diagnostic imaging, hematologic studies, and the metric system.
Level 2 **Comprehend**	Identify the various diagnostic procedures involved in imaging and blood and urine analysis.
Level 3 **Apply**	Relate medical terms and abbreviations to their specific diagnostic tests.
Level 4 **Analyze**	Analyze diagnostic terms to determine their meanings and usage.
Level 5 **Synthesize**	Combine your knowledge of medical diagnostic terms and the metric system to better understand health care–related processes.
Level 6 **Evaluate**	Gauge your understanding of medical diagnostic terminology and abbreviations through the interpretation of medical case studies.

Introduction

While not covered in many traditional medical terminology texts, there are numerous medical terms and abbreviations associated with diagnostic testing. Our goal is to give you a solid understanding of these medical terms and abbreviations while giving you a basic understanding of the diagnostic tests or procedures.

Remember the cold that developed into pneumonia in Chapter 1? The pneumonia was most likely diagnosed with a culture and sensitivity (C&S) test and a chest X-ray (CXR). It's important to understand the basics of what a culture and sensitivity test is or you might think they are checking the patient for their knowledge of opera or how easily they get upset. Seriously, a good understanding of common diagnostic terms and tools will not only help you in your medical profession but also in your personal medical quality of life.

So now that you have visited your PCP, it is time to understand the battery of tests they can order for you to help determine your diagnosis. Keep in mind, a diagnosis is not solely based on test numbers and must be coupled with a good patient history and assessment, as each patient is inherently unique.

Just as in Chapter 1, the Medical Clipboards will provide you with a preview of the words to come in each section. Some words, designated Key Terms, appear in bold within the text and many of these are also listed in the chapter margins for easy reference. At the end of the chapter, you will find the Key Terms and Abbreviations section, which has all the terms you should know from the chapter. Before moving on, take a look at the Medical Clipboard on the next page. You may already be familiar with some of the terms, or you may have heard them used before.

2.1 Imaging Terms and Abbreviations

Medical Clipboard 2-1

Use the provided checkboxes to check off any prefixes, combining forms, suffixes, or abbreviations you already know. Continue to check them off as you study the chapter until you have learned them all.

Prefixes *Placed in the beginning of a term to change its meaning*

✓	Prefix	Meaning
☐	Contra-	Against or not
☐	Ultra-	Beyond

Combining Forms *Consist of a word root with a combining vowel (usually o) so you can add other word parts*

✓	Combining form	Meaning
☐	Anter/o	Front
☐	Bronch/o	Airway
☐	Lip/o	Fat
☐	Poster/o	Back or behind
☐	Pharmaceut/o	Drug
☐	Radi/o	X-ray, radioactive
☐	Son/o	Sound
☐	Techn/o	Skill
☐	Tom/o	Section

Suffixes *The ending of a word that modifies its meaning and can be used to form a noun, adjective, or verb*

✓	Suffix	Meaning
☐	-al	Pertaining to
☐	-ical	Pertaining to
☐	-ior	Pertaining to
☐	-graph	Instrument for recording
☐	-grapher	One who is skilled in producing recordings
☐	-graphy	Process of recording
☐	-logist	One who studies
☐	-logy	Study of
☐	-lucent	To shine
☐	-oma	Tumor
☐	-opaque	Obscure

Abbreviations *A shortened version of a word*

✓	Abbreviation	Meaning
☐	AP	Anteroposterior view
☐	CT	Computed tomography
☐	CXR	Chest X-ray
☐	MRI	Magnetic resonance imaging
☐	PA	Posteroanterior view
☐	PET	Positron emission tomography

2.1a The Radiology Department

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You have probably been sent to the **radiology** department at some point in your life. You might think the term means the study of radios but actually it is a branch of medicine that uses *radiant* forms of energy or *radioactive* substances to diagnose and treat disease.

Within the radiology department, there are many key people you will encounter. A **radiology technologist** (or "rad tech," for short) is the professional who performs the imaging procedures we will soon discuss. These individuals can specialize in various types of imaging procedures such as X-ray, CT, and MRI, to list a few. These individuals can cross-train in different specializations to enable themselves to do more than one type of imaging. A **radiologist**, on the other hand, is the physician who specializes in interpreting the various images produced. Let's discuss some of the imaging procedures, beginning with the most common one: the **X-ray**.

Radiology
Medical profession utilizing medical imaging to treat and diagnose conditions of the body

Radiology technologist
Profession that assures quality diagnostic imaging is produced

Radiologist
A medical doctor specializing in diagnosing and treating injuries and diseases using medical imaging

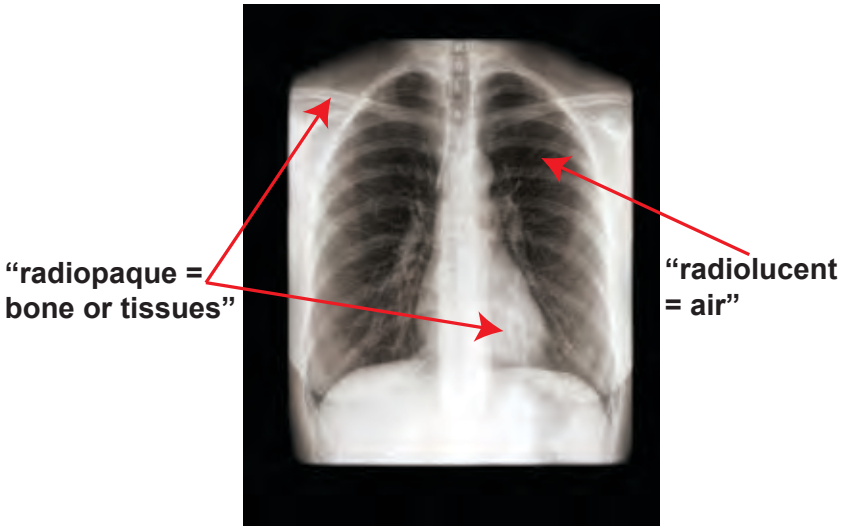
2.1b X-Rays

If you went to the hospital or your PCP's office due to a bad ankle sprain or possible broken bone, the chances are good they would order you an X-ray. An X-ray uses a ray of electrons that are projected toward a particular area of the patient. Placed opposite the X-ray machine is a film that produces an image based on whether the electrons are absorbed or deflected, which depends on the type of body tissue they hit. The actual film itself is called a *radiograph* (radi/o = X-rays, -graph = instrument for recording).

Additional terms you may hear associated with X-rays are *radiolucent* (radi/o = X-ray, -lucent = to shine) and *radiopaque* (radi/o = X-ray, -opaque = obscure), used to describe the images. *Radiolucent* means X-rays can pass or shine through the body easily and appear black on the X-ray image. So, when the X-rays pass through the air in the lungs, it is radiolucent and appears black in the image, as can be seen in Figure 2-1. However, denser tissue, such as bone, is radiopaque. *Radiopaque* means the X-rays are absorbed or obscured by a structure and do not reach the X-ray film, appearing white in the image, as in the bones of the rib cage in Figure 2-1.

When getting an X-ray, there are certain positions you will be placed in to get the desired image. The following are common X-ray positions based on where the X-ray machine is placed in reference to the body.

Figure 2-1 Image of a Chest X-Ray



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- **Anteroposterior view (AP)** (anter/o = front, poster/o = back or behind, -ior = pertaining to) is when the X-ray machine is placed in front of the body, or at the *anterior,* and the film is placed at the *posterior*, or back.
- **Posteroanterior view (PA)** (poster/o = back or behind, anter/o = front, -ior = pertaining to) is when the X-ray machine is placed at the *posterior*, or back, and the film is placed at the *anterior*, or front.
- **Lateral view** is when the X-ray machine is directed at a patient's side, and the detector is placed at the opposite side.
- **Oblique view** is an X-ray taken at a slight angle in order to gain an image of a structure that would otherwise be obscured in an AP or PA view.

Figure 2-2 Posteroanterior Chest X-Ray

PA CXR showing left-sided pneumonia. Notice the black or radiolucent areas where the X-rays passed easily through the air in the lungs and the white or radiopaque areas where the X-rays hit bone (like the ribs); now look at the white area indicating secretions and fluid in the left lower lung.

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Learning Hint 2–1

If you take a close look at the CXR in Figure 2-2, you will notice an L on the right side as you are looking at it. The L signifies that that side of the CXR is the patient's left side. Always keep in mind that your left and right will not always be the patient's left and right. You must always refer to the patient's left and right.

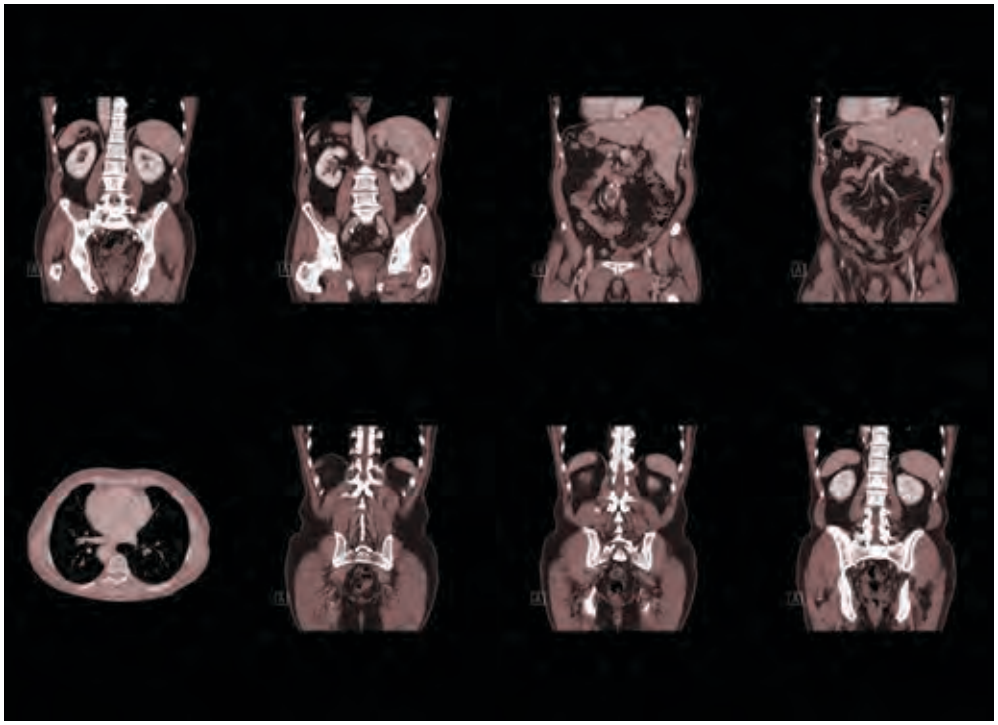
2.1c Computed Tomography (CT) Scan

Computed tomography (CT)
Utilizes X-rays and a computer to create images of the body

CT technologist
An individual who operates CT equipment to produce an image

The individual performing the **computed tomography** (CT) scan is a **CT technologist**. The word root *tomos* means "to cut"; a CT scan takes X-rays of thin sections or slices of the body that the computer reconstructs to give a detailed 3-D images of bones, organs, and vessels. Please see Figure 2-3.

Figure 2-3 CT Scan of the Abdominal Region



This scan can provide more detailed images than a standard X-ray. A CT scan provides physicians with cross-sectional slices of the body from different angles. To obtain clear pictures of a structure surrounded by tissues of similar densities, contrast medium is injected into the structure of interest to make it stand out on the scan.

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2.1d Magnetic Resonance Imaging (MRI)

Magnetic resonance imaging
An imaging procedure that utilizes strong magnetic fields to obtain detailed images of the body

MRI technologist
A radiology technologist who specializes in magnet resonance imaging

You may have heard the abbreviation **MRI** at one time or another; it is now a fairly common scan. MRI stands for **magnetic resonance imaging**. The clinician who operates the machine is called an **MRI technologist**; they gather the images for the radiologist to read. An MRI machine is a diagnostic imaging tool used to view structures made of soft tissue. These machines can develop detailed 3D images of the body. For example, an MRI can be used to evaluate a torn ligament, which is made of soft connective tissue that connects bone to bone and would not show up on conventional X-rays. Also, while X-rays and CT scans use radiation to view inside your body, an MRI takes a different approach and instead uses magnets and radio waves. See photos below, showing an MRI machine and an MRI image of a head.

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MRI image of the brain and an MRI machine

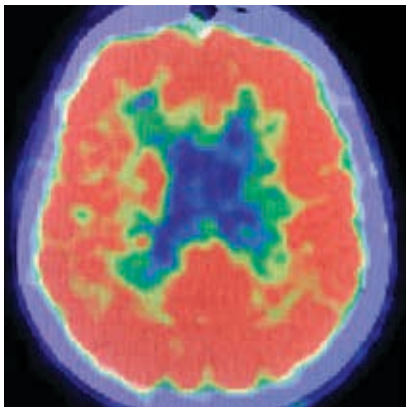
Clinical Application 2–1

Precautions for MRI Testing

Contraindicated
When a certain diagnostic test or procedure should not be done

Since the MRI procedure is done with magnets, any metal objects—like jewelry and even objects the patient has inside their body, like a pacemaker or metal shavings in the eye—are **contraindicated** (contra- = against or not), meaning this procedure should not be done if metal objects are worn or placed within range of the MRI machine.

2.1e Positron Emission Tomography (PET) Scan


Getty Images

PET scan of the brain

Positron emission tomography (tom/o = section; -graphy = process of recording) or **PET** is a commonly used type of nuclear medicine scan. **Nuclear medicine** uses radioactive material to diagnose and treat disease. When radioactive material is injected into the patient for imaging purposes, it is known as a *tracer*. PET scans not only provide an image but also give physicians a look into how well or poorly the body system or organ of interest is functioning. One common use for this kind of imaging process is to detect the presence of certain cancers.

Nuclear medicine technologists are the individuals who prepare the radioactive drugs, known as **radiopharmaceuticals** (radi/o = radioactive, pharmaceut = drug, -ical = pertaining to), and administer them to patients. While the majority of these professionals work in hospitals, some may find employment at physician's offices or imaging centers.

Nuclear medicine
A medical specialty that utilizes radioactive substances for diagnostic and therapeutic purposes

2.1f Ultrasound

This type of imaging practice utilizes sound waves to produce an image of the patient's anatomy. **Sonography** (son/o = sound, -graphy = process of recording) involves taking and interpreting images created by soundwaves as they are returned to the *transducer*. The sound waves used are *ultrasound* (ultra- = beyond), hence this procedure is called an **ultrasound**. Because the frequency of the sound waves is above the range of human hearing, the procedure is silent.

Sonography (son-OG-rah-fee)
The process of recording a sonogram or ultrasound

This type of imaging is performed by a **sonographer** (sono- = sound; -grapher = one who records), also referred to as an *ultrasound technologist*. Sonographers can work in specialized areas of care, such as in the hospital's vascular laboratory getting images of vessels or in obstetrics obtaining images of fetal development during pregnancy.

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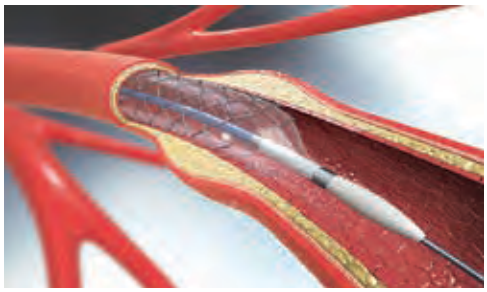
Ultrasound image of a fetus

Clinical Application 2–2

Interventional Radiology

Radiology is a large field with different subspecialties. For example, *interventional radiology* uses a combination of imaging and minimally invasive, image-guided procedures. An example of an interventional radiology procedure is when a physician places a *stent* (a device that keeps a vessel open) in a patient's coronary artery to ensure sufficient blood gets to the heart muscle, with no obstruction, to prevent a heart attack.



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2.1g Singular and Plural in Medical Terminology

Just as with words in English, you can have singular and plural medical terms. In English, it is simple to make a word plural; it usually involves adding an *s* to the end of the word. It's a little trickier with medical terms, as the plural form is dictated by the ending of the singular term.

For example, in Chapter 1, your PCP needed to determine whether your bad cold was actually something more. One way to do that would be to order a CXR to get an image of your lungs. During this process, you would hear certain terms used in either a singular or plural form. The doctor would examine all sections of your lungs. The upper portion of one lung is called the *apex*. If the upper portions of both lungs are involved, the term changes to its plural form, *apices*. The rule for singular terms that end in *-ex* is to change the suffix to *-ices* to make it plural.

Your airways would also need to be evaluated. *Bronchus* (bronch/o = airway)—in this case referring to the right mainstem bronchus, which is the large airway leading into the right lung—is the singular form. However, if you were discussing several airways, the plural form is *bronchi*. For singular medical terms ending in *-us*, the suffix changes to *-i* to make it plural.

Table 2-1 lists some common singular and plural word forms with examples.

Table 2-1 Singular and Plural Forms

Rules	Singular examples	Plural examples
Terms ending in -a become plural with the addition of an -e at the end of the word.	Vertebra Single bone in spinal column	Vertebrae Several bones in spinal column
Terms ending in -ix or -ex become plural by removing either the -ix or -ex and adding -ices.	Apex Upper portion of one lung	Apices Upper portions of both lungs
Terms ending in -us become plural by removing the -us and adding an -i.	Bronchus Single airway	Bronchi Multiple airways
Terms that end in -x becomes plural by removing the -x and adding a -ges.	Meninx Any of the three membranes that cover the brain and spinal cord	Meninges Referring to more than one meninx
Terms ending in -y become plural by removing the -y and adding -ies.	Biopsy One sampling of tissue	Biopsies Multiple samplings of tissue
Terms ending in -ax become plural by removing the -x and adding -ces.	Thorax One chest	Thoraces Several chests
Terms ending in -ma become plural with the addition of -ta.	Lipoma One fatty tumor (lip/o = fat, -oma = tumor)	Lipomata Several fatty tumors

Medical Checkup 2-1

1. Match each combining form to the correct meaning.

____ Anter/o	a. side
____ Poster/o	b. front
____ Later/o	c. back

2. Which of the following is produced using soundwaves and a transducer?

   a. Radiograph
   b. MRI scan
   c. Sonogram
   d. CT scan

3. Which imaging technique would best show a soft tissue abnormality in detail?

   a. MRI
   b. X-ray
   c. Ultrasound
   d. PET scan

4. Match each singular form to the correct plural form.

____ -ix	a. -i
____ -us	b. -ices
____ -a	c. -ies
____ -y	d. -ae

5. Which scanning procedure does not expose you to radioactive energy or sound waves?

   a. X-ray
   b. MRI
   c. CT scan
   d. Sonography

2.2 The Mathematical Language of Medicine: The Metric System

Medical Clipboard 2-2

Please review the following metric abbreviations, as you will soon learn how they are used. The metric system revolves around the number 10. If you don't know what *power of 10* means, don't worry, it will be explained shortly.

Abbreviations

✓	Prefix	Math meaning	Power of 10
☐	Kilo-	1000 times	10^{3}
☐	Hecto-	100 times	10^{2}
☐	Deca-	10 times	10^{1}
☐	Deci-	One tenth	10^{-1}
☐	Centi-	One hundredth	10^{-2}
☐	Milli-	One thousandth	10^{-3}
☐	Micro-	One millionth	10^{-6}

✓	Metric base unit of measure	Use
☐	Gram	Used for weight
☐	Liter	Used for volume
☐	Meter	Used for length

2.2a The Metric System

In the next section of this chapter, we will cover laboratory and diagnostic tests. Many of the values will have units of measurement that you may or may not be familiar with, such as deciliters, kilograms, or millimeters. These units represent the "mathematical" language of medicine, called the metric system.

For example, fluids and medications are measured in milliliters (mL) and drug dosages can be based on milligrams per kilogram. You may be thinking, "Great, I am trying to learn one new language and now I have to learn another one too?!" Well, don't get worried, you will see that with practice, it is not as hard as it may seem. Let's begin with a brief history lesson.

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There are two major measurement systems in existence, the US Customary System (USCS) and the International System of Units (SI), also known as the metric system. In the United States, the primary measurement system used is the US Customary System. This system is commonly known as the English system, as it was derived from the British Imperial System. This system is used for general measurements and has different units used for volume, length, and weight. While the English system is used in the US, the metric system is used as the standard of measurement around the globe as well as in health care.

Let's use volume as an example of how these two systems differ. The USCS uses pints, quarts, gallons, pecks, and bushels to measure volume, and many values or equivalencies must be memorized. By the way, what the heck is a peck? The metric system is much easier in that it only has one main unit of measure for volume called the liter; prefixes based on powers of 10 are placed before the unit to let you know just how many liters you are dealing with.

To convert within the metric system, you will soon learn it is as easy as moving a decimal point—versus doing all kinds of calculations to convert within the English system. First, let's discuss the "powers of 10" the metric system is based on.

The Powers of 10

Understanding exponents and how to use them will greatly assist you in using the metric system. So, before we move forward, let's quickly review what an exponent is and how it works, using an example. Let's use 5^4. Since exponents are also called powers, this example could also be expressed as "5 to the 4th power." The number 5 is the base number, the 4 is the exponent. The exponent tells you how many times to multiply the base number by itself. So, 5^4 is $5 \times 5 \times 5 \times 5$, which is 625.

Keep in mind that when the base number has an exponent of 0, it always equals 1. For example, $5^0 = 1$. The metric system uses the powers of 10, meaning 10 is the base; Figure 2-4 gives some examples.

Figure 2-4 The Powers of 10

$\mathbf{10}^0 = 1$*
$\mathbf{10}^1 = 10$
$\mathbf{10}^2 = 10 \times 10 = 100$
$\mathbf{10}^3 = 10 \times 10 \times 10 = 1\,000$
$\mathbf{10}^4 = 10 \times 10 \times 10 \times 10 = 10\,000$
$\mathbf{10}^5 = 10 \times 10 \times 10 \times 10 \times 10 = 1\,00\,000$
$\mathbf{10}^6 = 10 \times 10 \times 10 \times 10 \times 10 \times 10 = 1\,000\,000$

*Remember, any number to the 0 power = 1

Clinical Application 2–3

Scientific Notation

Another reason why powers of 10 are so helpful is they can be used in scientific notation, which is often used in health care articles. For example, there are about 25 000 000 000 bloods cells floating around your bloodstream. If this had to be written out each time it appeared in an article, it could become very cumbersome. We can take this large number and express it in an abbreviated form called *scientific notation*. For scientific notation, the rule is to move the decimal point so that you have only one number to the left of the decimal point, then multiply by the appropriate power of 10 to express the number of places you moved the decimal point. Therefore, 25 000 000 000 becomes 2.5×10^{10}. Keep in mind that for numbers larger than one, the decimal point, while not written, is always at the end of the number.

Now that we've covered positive exponents, let's take a look at negative exponents. A negative exponent results in numbers that are less than 1. You can think of them as fractions. Figure 2-5 lists some examples of powers of 10 with negative exponents.

Figure 2-5 Negative Exponents

$\mathbf{10}^{-1} = 1/10 = 0.1$
$\mathbf{10}^{-2} = 1/10 \times 1/10 = 0.01$
$\mathbf{10}^{-3} = 1/10 \times 1/10 \times 1/10 = 0.001$
$\mathbf{10}^{-4} = 1/10 \times 1/10 \times 1/10 \times 1/10 = 0.0001$
$\mathbf{10}^{-5} = 1/10 \times 1/10 \times 1/10 \times 1/10 \times 1/10 = 0.000\,01$
$\mathbf{10}^{-6} = 1/10 \times 1/10 \times 1/10 \times 1/10 \times 1/10 \times 1/10 = 0.000\,001$

Clinical Application 2–4

Scientific Notation for Numbers Less Than 1

Just like in the previous example, where we took a large number and expressed it in a way that was more manageable to write, we can take a small number and do the same thing. Again, keep in mind that each decimal movement is a power of 10.

Let's say you are measuring the size of a microorganism and it is 0.000 000 5 meters. This number would become 5.0×10^{-7}, as moving the decimal to the right gives a negative value, showing the number is less than 1.

Learning Hint 2–2

When using scientific notation, if you are moving the decimal to the right, you will need a negative exponent and the number is always less than one. If you are moving the decimal to the left, the exponent should be positive and the number is always greater than one.

2.2b Metric System Prefixes

There are three basic things you can measure. How heavy is something (weight)? How much space does something occupy (volume)? What is the distance between two points (length)? The metric system has only one base unit for each of these measurement types: **meter** for length, **liter** for volume, and **gram** for weight (or mass).

Meter
Metric unit measuring length

Liter
Metric unit measuring volume

Gram
Metric unit measuring weight (or mass)

Learning Hint 2–3

In the sciences there is a difference between mass and weight. Mass refers to the actual amount of matter in the object whereas weight is the force exerted on the body by gravity. In space, or zero gravity, objects have mass but no weight; since health care is mostly confined to Earth, where there are gravitational forces, we will use the term weight.

As stated before, the prefixes placed before the metric base units tell you the power of 10 and therefore how much of the unit you have. See Table 2-2 for prefixes, their abbreviations, and the associated powers of 10.

Table 2-2 Common Metric System Prefixes

Prefix	Kilo-	Hecto-	Deca-	No prefix	Deci-	Centi-	Milli-
Numeric value	1 000	100	10	1	1/10	1/100	1/1 000
Abbreviation	**k**	**h**	**da**	**m** (meter), **L** (liter), **g** (gram)	**d**	**c**	**m**
Power of 10	10^3	10^2	10^1	10^0 or 1	10^{-1}	10^{-2}	10^{-3}

Looking at Table 2-2, you can see that a kilogram is 1000 grams and a milliliter is 1/1000 of a liter. So, in looking at the chart, you can easily convert any metric unit as shown in the following examples.

Example 1

100 g = _____ mg

Look at the chart. You are starting with grams (ie, with no prefix) and you want to get to milligrams. The prefix *milli-* means 1/1000 or 10 to the power of –3. This means you need to move your decimal point 3 to the right. Starting with 100, we move the decimal 3 to the right and the answer is 100 000 milligrams.

Example 2

2 000 000 cg = _____ kg

Looking at the chart, you are starting with centigrams and you want to get to kilograms. The prefix *centi-* means 1/100 or 10 to the power of –2. The prefix *kilo-* means 1000 or 10 to the power of 3. Looking at the chart you are moving 5 powers of ten to the left, which means you need to move the decimal point 5 to the left. The answer is 20 kilograms.

Example 3

500 mL = _____ L

Looking at the chart, you are starting with milliliters and you want to get to liters (ie, with no prefix). Looking at the chart milli and liters are three powers of 10 apart. This means you need to move your decimal point 3 to the left. The answer is 0.5 liters.

Clinical Application 2–5

An Important English to Metric Conversion

Often a patient will be weighed using pounds as the unit. However, drug dosages are often calculated in kilograms. For example, a drug might have a dose of 10 milligrams per kilogram of body weight. To convert pounds to kilograms, you simply divide the pounds by 2.2. So, a 200-pound patient would be approximately 90 kilograms. Since the dose is 10 milligrams per kilogram, you would give 900 milligrams (90 × 10) of medication.

Table 2-3 lists the common metric units of measure that you will encounter in health care.

Table 2-3 Common Medical Metric Units

Abbreviation	Meaning
dL	Deciliter
cm	Centimeter
g	Gram
mcg	Microgram (micro- means 1/1 000 000 or 10^{-6})
g/dL	Grams per deciliter
kg	Kilogram
L	Liter
mL	Milliliter
mm	Millimeter
mEq	Milliequivalent (used in the measurement of compounds in biological fluids; one example is the measurement of body electrolyte levels)

Medical Checkup 2-2

1. Which of the following metric base units is used for volume?
   a. Gram
   b. Liter
   c. Meter
2. Which of the following values appropriately reflects 3.5×10^{10}?
   a. 3.5
   b. 35 000 000 000
   c. 35 000 000
   d. 3 500
3. Which of the following is the correct scientific notation for 100 000?
   a. 1.0×10^{3}
   b. 1.0×10^{5}
   c. 1.0×10^{10}
   d. 1.0×10^{6}
4. Two liters is equal to how many milliliters?
   a. 1 000 mL
   b. 0.2 mL
   c. 0.002 mL
   d. 2 000 mL
5. Match the following prefixes with their correct numerical values.

____ Hecto-	a. 10
____ Kilo-	b. 1/100
____ Milli-	c. 1/1 000
____ Deca-	d. 1 000
____ Centi-	e. 100

2.3 Laboratory Studies and Associated Medical Terms and Abbreviations

While the goal of this textbook is to teach medical terminology and not diagnostics or anatomy and physiology, students entering health care are often overwhelmed reading medical records when they encounter terms related to diagnostic testing and results. Therefore, this section will give you a basic understanding of some of the more common diagnostic tests you will encounter along with their medical abbreviations. Please review the terms and abbreviations covered in this section to see which ones you already know. In addition, more diagnostic tests will be covered in the upcoming specialist chapters.

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Medical Clipboard 2-3

Use the provided checkboxes to check off any prefixes, combining forms, suffixes, or abbreviations you already know. Continue to check them off as you study the chapter until you have learned them all.

Prefixes *Placed in the beginning of a term to change its meaning*

✓	Prefix	Meaning
☐	A-	No, without
☐	An-	No, without
☐	Anti-	Against
☐	Calc-	Calcium
☐	Hyper-	Above, excessive
☐	Hypo-	Below normal, deficient
☐	Macro-	Large
☐	Mono-	One
☐	Poly-	Many

Combining Forms *Consist of a word root with a combining vowel (usually o) so you can add other word parts*

✓	Combining form	Meaning
☐	Amyl/o	Starch
☐	Bas/o	Base
☐	Bilirubin/o	Bilirubin
☐	Chlor	Chloride
☐	Cyan/o	Blue
☐	Cyt/o	Cells
☐	Eosin/o	Red or rosy coloration
☐	Erythr/o	Red
☐	Gluc/o	Sugar
☐	Glyc/o	Sugar or glucose
☐	Hem/o	Blood
☐	Hepat/o	Liver
☐	Kal/o	Potassium
☐	Leuk/o	White
☐	Lip/o	Fat
☐	Magnes/o	Magnesium
☐	Morph/o	Shaped
☐	Natr/o	Sodium
☐	Neutr/o	Neutral
☐	Nucle/o	Nucleus
☐	Phag/o	Swallow
☐	Phleb/o	Vein
☐	Phosphat/o	Phosphate
☐	Splen/o	Spleen
☐	Strept/o	Chains
☐	Thromb/o	Clot
☐	Tom/o	To cut into or insert
☐	Ur/o	Urine
☐	Xanth/o	Yellow

Suffixes *The ending of a word that modifies its meaning and can be used to form a noun, adjective, or verb*

✓	Suffix	Meaning
☐	-ase	Enzyme, "to break down"
☐	-blast	Immature
☐	-coccus	Sphere
☐	-crit	Separate
☐	-cyte	Cell
☐	-emia	Blood
☐	-globin	Protein
☐	-logy	Study of
☐	-megaly	Enlarged
☐	-meter	Measure
☐	-osis	Condition of
☐	-penia	Deficiency
☐	-phage	Eat or swallow
☐	-phil	Attraction to
☐	-poiesis	Formation
☐	-poietin	Substance that forms
☐	-uria	Urine

Continues

Medical Clipboard 2-3

Continued

Abbreviations *A shortened version of a word*

✓	Abbreviation	Meaning
☐	A1c	Glycated hemoglobin
☐	ALP	Alkaline phosphatase
☐	ALT	Alanine aminotransferase
☐	AST	Aspartate aminotransferase
☐	BUN or SUN	Blood urea nitrogen; also known as serum urea nitrogen
☐	C&S	Culture and sensitivity
☐	Ca	Calcium
☐	CBC	Complete blood count
☐	Cl^-	Chloride
☐	CMP	Comprehensive metabolic panel
☐	Diff	Differential leukocyte count
☐	HCT	Hematocrit (this abbreviation should be avoided because of the possibility of confusion with hydrocortisone and hydrochlorothiazide; when in doubt, write it out)
☐	HDL	High-density lipoprotein

✓	Abbreviation	Meaning
☐	Hgb	Hemoglobin
☐	K^+	Potassium ion
☐	LDL	Low-density lipoprotein
☐	Mg	Magnesium
☐	Na^+	Sodium ion
☐	PLT	Platelets
☐	PO_4	Phosphate
☐	PT	Prothrombin time
☐	RBC	Red blood cells
☐	sg	Specific gravity
☐	UA	Urine analysis, urinalysis
☐	UTI	Urinary tract infection
☐	WBC	White blood cells

2.3a Hematology Studies

Hematology (hee-mah-TOL-oh-gee)
A branch of medicine that studies the blood

Phlebotomist (fleh-BOT-oh-mist)
Someone who specializes in collecting blood samples

Since blood is involved in all aspects of our body, blood samples can be taken to learn so much about the health of a patient. Once a blood sample is drawn, it is then sent to the laboratory to be studied. The study of blood is known as **hematology** (hem/o = blood, -logy = study of). Often, a blood sample is obtained by a person who specializes in collecting blood samples. This individual is known as a **phlebotomist** (phleb/o = vein, tom/o = to cut into or insert). A phlebotomist inserts needles into the vein to sample blood for analysis.

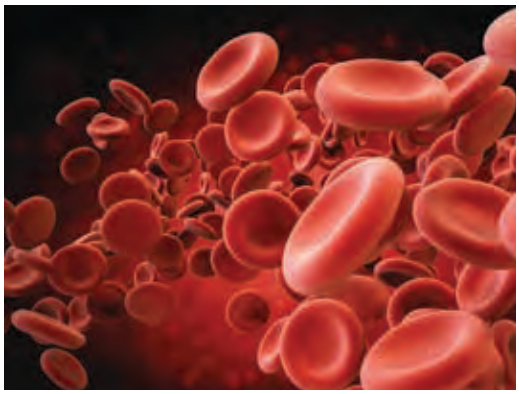
2.3b Complete Blood Count (CBC)

The blood in our body serves multiple purposes to keep the body functioning properly. The liquid portion of blood is called **plasma**. Even though we can't see them with the naked eye, there are numerous cells and substances within that plasma, and by analyzing them, we can learn about how well the body is functioning. The specialized cells found in plasma are as follows:

- *red blood cells* (RBC), also known as **erythrocytes** (erythr/o = red, -cyte = cell);
- *white blood cells* (WBC), also known as **leukocytes** (leuk/o = white, -cyte = cell);
- and *platelets*, also known as **thrombocytes** (thromb/o = clot, -cyte = cell).

One of the most commonly ordered tests is a **complete blood count** (CBC). This test is very useful, as it examines many cellular components in the blood. This blood test looks at the red blood cell count, white blood cell count, hematocrit, and hemoglobin.

2.3c Red Blood Cells



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Red blood cells (RBC), or erythrocytes, are chiefly responsible for carrying oxygen from the lungs and transporting it to body tissue. Erythrocytes are created in the bone marrow. When the body is triggered to produce more RBC, a hormone called **erythropoietin** (erythr/o = red, -poietin = substance that forms) is secreted from the adrenal glands causing **erythropoiesis** (erythr/o = red, -poiesis = formation) or formation of red blood cells.

When these new RBC first develop, they are immature. At this immature stage, these cells are called **erythroblasts** (erythr/o = red, -blast = immature). Once the cells mature, they become functioning erythrocytes and develop into the recognizable doughnut shape as shown. RBC make up the majority of blood cells found within the plasma, and this is what gives blood its reddish color.

Once blood has been collected from the patient, the lab measures the number of RBC. This is done by measuring the number of RBC contained in a cubic millimeter (mm^3) of blood. The normal number of RBC varies between men and women.

Erythropoietin (eh-RITH-roh-poy-et-in)
Hormone produced primarily by the kidneys to increase the production of red blood cells

Erythropoiesis (eh-RITH-roh-poe-ee-sis)
Formation of red blood cells

Erythroblast
Immature red blood cells

Clinical Application 2–6

Jaundice

Once a red blood cell has aged and is unable to perform as it should (usually 120 days), it is destroyed by cells called **macrophages** (macro- = large, -phage = eat or swallow). When these RBC are destroyed, **bilirubin** is formed. Bilirubin has a yellowish-orange coloration that can cause the patient's skin and the whites of the eyes to become yellow in color. If too much bilirubin builds up in the blood, it is known as **hyperbilirubinemia** (hyper- = above, excessive; -emia = blood condition) or **jaundice**. This usually means the patient's liver is unable to excrete the bilirubin and its buildup causes the yellowish color known as **xanthemia** (xanth/o = yellow, -emia = blood).

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Comparison between normal skin coloration versus jaundice

2.3d Hematocrit

Hematocrit (hee-MAT-oh-krit)
A blood test used to see how many blood cells are in the plasma

Another important value related to the number of red blood cells in plasma is **hematocrit** (HCT) (hem/o = blood, -crit = separate). Just as the name implies, the blood is separated so the red blood cells can be measured. To perform this test, a sample of blood is spun in a **centrifuge** (a machine that spins very fast) and the RBC, which are heavier, separate from the rest of the liquid blood in the tube and settle at the bottom. The height of the RBC found at the bottom of the tube is measured, giving the volume of RBC in 100 milliliters (mL) of blood. Higher HCT values would mean the blood is thicker or more viscous and therefore harder to circulate around the body. Photos in Section 2.3e show the layering and color differences in blood samples after they have gone through a centrifuge.

2.3e Hemoglobin (Hgb)

An important protein found in RBC, allowing them to carry oxygen to tissues in the body, is called **hemoglobin** (Hgb) (hem/o = blood, -globin = protein). Hemoglobin levels are measured in grams per deciliter, or g/dL, to determine if the individual has enough to properly carry oxygen throughout the body

Hemoglobin
Protein in the blood responsible for transporting oxygen

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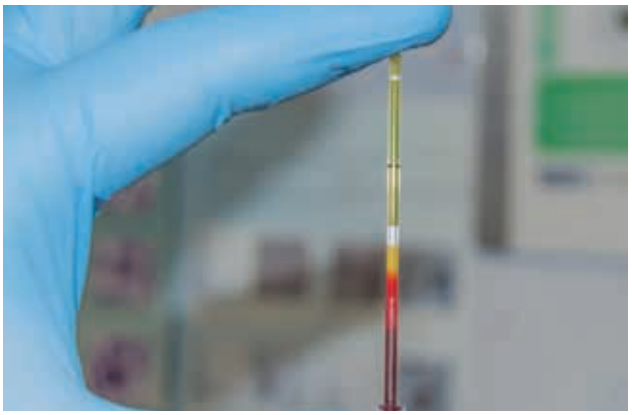
Tubes of blood in a centrifuge



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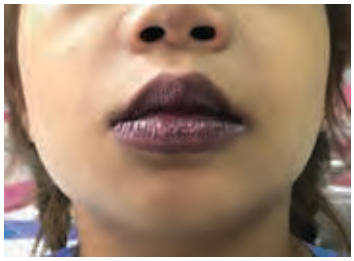
Blood sample collected via a capillary tube shows the red blood cells separated from the yellowish fluid, called plasma.

Clinical Application 2–7

Two Major Red Blood Cell Disorder Classifications



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Bluish coloration of lips as a result of being cyanotic.

Anemia (a-, an- = no, without; -emia = blood condition) is a blood disorder classification where the body is not producing enough RBC; this greatly affects the ability to carry oxygen. When hemoglobin is combined with oxygen, it becomes bright red. Low oxygen levels will produce a darker colored blood and therefore give a bluish appearance to the skin. This condition is called **cyanosis** (cyan/o = blue, -osis = condition of).

Cyanosis (sigh-ah-NOH-sis)
A bluish coloration of the skin and mucous membranes as a result of low oxygen levels

Polycythemia (poly- = many, cyt/o = cells, -emia = blood), on the other hand, is a classification of blood disorders where there are too many red blood cells; this will increase the hematocrit and thicken the blood, often putting stress on the heart as it moves this thicker blood throughout the circulatory system.

Polycythemia (paul-ee-sigh-THEE-mee-ah)
Caused by a disease state where the body produces too many red blood cells

2.3f White Blood Cells (WBCs)

White blood cells', or leukocytes', primary job is to circulate in our bloodstream and protect us by fighting infection. There are many different types of WBCs, each with a different role, as there are many different types of infections and diseases they must fight. When an infection is present, the patient's WBC count will be increased as the body produces more WBCs to fight the foreign invader. The 5 main forms of WBCs can be divided into two main groups known as **mononuclear leukocytes** and **polymorphonuclear leukocytes**. Again, knowing the word parts can give you information about how the cells look under the microscope.

Mononuclear leukocytes would have one (mono- = one) nuclei and *polymorphonuclear leukocytes* would have many (poly- = many) different shaped (morph/o = shaped) nuclei. Polymorphonuclear leukocytes are also called **granulocytes** because the cells look like they have grains of sand in them; mononuclear leukocytes are *agranular* (a- = without).

Clinical Application 2–8

How Medical Terminology Can Help Your Studies

Knowing word parts can help you in your anatomy and physiology and microbiology classes. For example, the types of WBCs are called **basophils**, **eosinophils**, neutrophils, monocytes, and lymphocytes. The first three cell types are granulocytes, so they look granular (like there are grains of sand in them) under the microscope; they all have the suffix *-phil*, which means "attraction to." In this case, these cells are named after the kind of stain they are attracted to, allowing them to be seen better under a microscope. *Basophils* are dyed blue by a *basic* stain; *eosinophils* are dyed red by an acidic stain called *eosin*.

Basophil (BAY-soh-fill)
A type of WBC that increases in number in response to inflammation and blood disorders

Eosinophil (ee-oh-SIN-oh-fill)
A type of WBC that increases in number in response to allergic reactions

2.3g Differential Leukocyte Count (Diff)

The number of each of these types of WBCs increases in response to certain conditions experienced by the body. A WBC count counts all the WBCs in the body; a **differential leukocyte count** (Diff) determines the percentage of each type of WBC in the patient's blood to try to determine better what type of cell is prevalent, giving an idea of what type of infection is present. For example, an increase in **lymphocytes** can indicate a viral infection while an increase in **monocytes** can indicate a long-standing or chronic infection. **Neutrophils** are **phagocytic** (phag/o = to swallow) cells that increase during bacterial infections to, in essence, gobble up the dead bacteria.

Lymphocyte (LIM-foh-sight)
Immune system WBC that is found in lymph nodes

Neutrophil (NEW-troh-fill)
A type of WBC that increases in number in response to bacterial infections, inflammation, and stress

Clinical Application 2–9

White Blood Cell Disorders

If the body is experiencing a chronic infection and is unable to continue to produce enough WBCs to fight the infection, a condition known as **leukopenia** (leuk/o = white, -penia = deficiency) can occur. WBCs are vital for your survival. When diseases target these cells, if not stopped, it will eventually cause death in the individual. For example, **leukemia** is a cancer of the white blood cell. This is a treatable cancer; there are many different forms of leukemia.

Leukopenia (loo-koh-PEE-nee-ah)
Abnormally low count of white blood cells

Leukemia (loo-KEE-mee-ah)
A cancer of the blood

2.3h Platelets

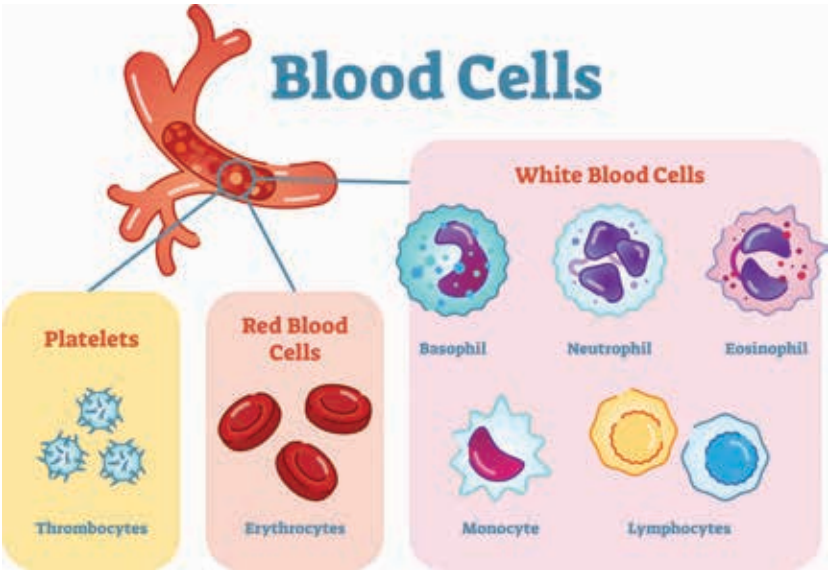
Platelets **(PLT)**, also known as thrombocytes (thromb/o = clot, -cyte = cell), are required to assist the blood in clotting as shown in Figure 2-6. Interestingly, while they are called cells, they are really cellular fragments that can range in shape from oval to flattened or round. Most of these "cells" can be found floating around in the bloodstream while a portion is stored in the spleen. Testing the patient's platelet count to determine how well the blood can clot is particularly useful, especially if the patient is on anticoagulant (anti- = against) therapy. If the patient has **thrombocytopenia** (thromb/o = clot, cyt/o = cell, -penia = deficiency), the sample of blood will contain less than the normal amount of platelets and the patient can be at risk of bleeding to death from a simple cut. Additional blood testing can be done to see how long it takes for the blood to clot; this is known as the **prothrombin time (PT)** or **pro time**. As signified in the name, this is a timed test that measures how fast the blood clots. The normal range for clotting time is 10-14 seconds.

Thrombocytopenia (throm-boh-sigh-toh-PEE-nee-ah)
Less than normal number of platelets in the blood

Prothrombin time
A diagnostic test used to determine the presence of an excessive clotting or bleeding disorder

Figure 2-6 Three Types of Blood Cells

This image shows three different types of cells. From left to right, there are platelets, red blood cells, and white blood cells.



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We have covered a lot of ground with the CBC test, but it does give the physician a wealth of diagnostic information. Please see Table 2-4 for a summary of the CBC test.

Table 2-4 CBC Test Summary

Cell type/test	Description	Conditions
Erythrocyte or red blood cell **(RBC)**	Transports oxygen throughout the body and collects carbon dioxide for removal	**Erythrocytosis** (erythr/o = red, cyt/o = cells, -osis = condition of) is a condition where there is an increase in the number of circulating RBC. For terminology referring to a low RBC count, see anemia under hematocrit in this table.
Leukocyte or white blood cell **(WBC)**	Fights infection	Leukopenia (leuk/o = white, -penia = deficiency) is a condition where there is a low WBC count. **Leukocytosis** (leuk/o = white, cyt/o = cells, -osis = condition of) is a condition where there is a high WBC count.
Platelet **(PLT)**	Clots blood	Thrombocytopenia (thromb/o = clot, cyt/o = cells, -penia = deficiency) is a condition characterized by not having enough platelets. **Thrombocytosis** (thromb/o = clot, cyt/o = cells, -osis = condition of) is a condition characterized by a high platelet count.
Hematocrit **(HCT)**	The ratio of total blood cells to the total fluid volume of blood	An increase in hematocrit is termed polycythemia*; this raises the blood viscosity
Hemoglobin **(Hgb)**	The protein in the red blood cell that carries oxygen throughout the body	Anemia (a-, an- = no, without; -emia = blood condition) is a condition where either there is a low RBC count or there is a decrease in hematocrit and hemoglobin levels.

*While, technically, polycythemia simply means many cells, since the red blood cell is the major cellular component of blood, it has come to mean high levels of red blood cells.

2.3i Lipid Profile

You may have heard of people getting their cholesterol checked. This laboratory test is called a **lipid profile**, which is done by taking a sample of the patient's blood. **Cholesterol** is a waxy substance produced by your body. It assists in making hormones and processing food. Cholesterol is produced by your own body and is present in some foods you ingest.

Cholesterol (koh-LES-ter-ol
A fatty, wax-like substance found in the blood

There is good and bad cholesterol, and it is important to know the difference. Too much bad cholesterol can cause a buildup of waxy plaque in your vessels, resulting in blockages of blood flow. **Low-density lipoprotein (LDL)** (lip/o = fat) is the bad cholesterol. These fatty proteins are a contributor to the development of plaque on the walls of your vessels. **High-density lipoprotein (HDL)** is the good cholesterol. HDL removes LDL from the vessel walls and then finds its way to the liver by way of the bloodstream. LDL is then excreted from the body after it reaches the liver. So, too much LDL clogs the arteries and HDL helps to clean them.

Learning Hint 2–4

Think of LDL as L for lousy cholesterol and HDL as H for helpful cholesterol.

Another value analyzed in a lipid profile is the patient's **triglycerides**. Triglycerides are found in the cells of your **adipose** (fat) tissue and come from the food you ingest. When triglycerides are at normal levels, energy is stored in your fat cells until it is needed. When triglycerides are present in excessive amounts in the blood, this fatty substance will also deposit on the vessel walls, causing an increased risk for heart disease (see Table 2-5).

Triglyceride (tri-GLISS-er-ides)
A type of fat or lipid found in the blood

Adipose (ADD-ih-pohs)
Fat tissue

Table 2-5 Triglyceride Levels

Clinical rating	Value range
Normal	Less than 150 mg/dL*
Borderline high	150 to 199 mg/dL
High	200 to 499 mg/dL
Very high	500 mg/dL or above

*milligrams per deciliter

2.3j Culture and Sensitivity

A culture and sensitivity or **C&S** can be used to determine what type of bacterial infection is present in the patient and what antibiotic will be most efficient at treating the patient. For example, if you had pneumonia as in our


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Agar plate showing cultured or grown bacteria exposed to different antibiotics to determine best one to use

example in Chapter 1, a sputum sample would be taken and then sent to a lab where the sample would be cultured, or grown, in a dish with different types of antibiotics placed throughout. The antibiotic that had the least amount of bacterial growth around it would be the most effective antibiotic in treating your particular infection. C&S studies can also be done on any body fluid, such as blood, or even on instruments, such as indwelling catheters (tubes), to see if a bacterial infection is present. Often, patients with long-term urinary catheters will develop a **UTI** or **urinary tract infection**.

2.3k Blood Sugar

Another blood test used to check the well-being of a patient is their blood **glucose** (gluc/o = sugar) levels. This measures the level of sugar found in the bloodstream. Glucose, or sugar, is needed to provide energy to your cells to maintain proper function. Patients can monitor their sugar at home by using a **glucometer** (gluc/o = sugar, -meter = measure). This device samples a drop of blood from a very small needle or lancet. This provides the user with an instant reading of their current blood sugar levels.

Glucometer (gloo-KOHM-eh-ter)
A device used to monitor blood sugar levels

Hypoglycemia
Below normal amount of sugar in the blood

Hyperglycemia (HI-po-gly-SEE-me-ah)
Excessive amount of sugar in the blood

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Glucometer testing blood sugar

After fasting (not eating and only drinking water) for 8 hours, a normal blood sugar level should be less than 100 mg/dL. If someone has low sugar, it is known as **hypoglycemia** (hypo- = deficient or below normal, glyc/o = sugar or glucose, -emia = blood condition). On the other hand, if someone has high blood sugar, it is called **hyperglycemia** (hyper- = above, excessive; glyc/o = sugar; -emia = blood condition).

Another test used to determine a patient's glucose levels is called an **A1c** or **glycated hemoglobin**. While our blood sugar levels are constantly changing, this test gives practitioners a look at how well a patient controlled their sugar over the past 3 months.

2.3l Electrolytes

Electrolyte levels can also be determined from a blood sample. Calcium, chloride, phosphate, potassium, magnesium, and sodium are the various electrolytes required by your body to function correctly. If you don't have the right levels of these electrolytes, possibly life-threatening complications may arise.

While the following terms related to electrolytes may seem complicated, you can break them down into easier to remember word parts. First, all the words start with either *hyper-* or *hypo-*. *Hyper* means above or excessive, and *hypo* means below normal or deficient. If you look at the ending of the terms, you will see they all end in *-emia*. The term *emia* means "blood condition." So, the only difference between these terms is the word root, which is associated with the different electrolytes. Check out Table 2-6 for the different electrolytes and imbalances.

Table 2-6 Electrolytes and Imbalances

Electrolyte, chemical symbol, and word root	Normal ranges	Imbalance (hyper- = above, excessive; hypo- = deficient or below normal)
Calcium **(Ca^{+2})** (calc-)	4.5-5.4 mEq/L	**Hypercalcemia** **Hypocalcemia**
Chloride **(Cl^{-})** (chlor)	95-103 mEq/L	**Hyperchloremia** **Hypochloremia**
Magnesium **(Mg^{+2})** (magnes/o)	1.5-2.4 mg/dL	**Hypermagnesemia** **Hypomagnesemia**
Phosphate **(PO_4^{-3})** (phosphat/o)	3.0-4.5 mg/dL	**Hyperphosphatemia** **Hypophosphatemia**
Potassium **(K^{+})** (kal/o)	3.5-5.0 mEq/L	**Hyperkalemia** **Hypokalemia**
Sodium **(Na^{+})** (natr/o)	136-145 mEq/L	**Hypernatremia** **Hyponatremia**

2.3m Comprehensive Metabolic Panel

There are many different types of panels, or groups of blood tests, used to check for certain body functions, such as liver and kidney function. However, one of the common panels ordered to obtain an overall picture of a patient's health is a **comprehensive metabolic panel (CMP).** This type of blood work requires the patient to fast, meaning no food or drinks other than water, for a certain time period, such as 12 hours. This commonly used panel consists of many different tests that examine the patient's metabolism, blood sugar, proteins in the blood, electrolytes, and more, as listed in Table 2-7.

Comprehensive metabolic panel
A blood test used to measure the patient's electrolyte levels, glucose level, fluid balance, and kidney and liver function

Table 2-7 Comprehensive Metabolic Panel

Clinical test	Testing explanation
Proteins	Albumin is a small protein that serves many different purposes, such as preventing fluid from leaking out of the bloodstream, and transporting vitamins, hormones, and enzymes throughout the body. Albumin is produced by the liver. Total protein measures albumin and other proteins in the blood.
Glucose	The amount of sugar in the blood. Glucose is needed to supply the body with energy. However, a balance must be maintained. Too much or too little glucose can adversely affect the body's function.
Electrolytes	Sodium is required for healthy nerve and muscle function. Potassium is needed for cell metabolism and muscle function. Chloride helps to maintain the amount of fluid in the body and acid-base balance. Calcium is needed for the proper functioning of the heart, muscles, and nerves. Additionally, it is required in bone formation and clotting blood.
Kidney tests	**Blood urea nitrogen (BUN)**, also known as serum urea nitrogen (SUN), is a waste product produced by body metabolism. The kidneys normally filter out this waste from the blood. If this level gets too high, it indicates a kidney issue. **Creatinine** is another waste product produced by the body; if not properly filtered from the blood and excreted, it can become toxic.
Liver tests	Also examined in the CMP are many different liver enzymes. They are as follows: **Alkaline phosphatase (ALP)** is an enzyme found in the liver as well as other tissues. If increased levels are present in the blood, it is likely that bone or liver disease is present. **Alanine aminotransferase (ALT)** is an enzyme found in liver cells. If the liver becomes damaged or inflamed, high levels of this enzyme is an indicator. **Aspartate aminotransferase (AST)** is an enzyme found in cells in the heart and liver. High levels can indicate liver or heart disease.

Learning Hint 2–5

Looking at the terms in Table 2-7, such as alkaline phosphatase and aspartate aminotransferase, you can see that they both end in *-ase*. This term means enzyme or "to break down." For example, **lipase** (lip/o = fatty) breaks down fats and **amylase** (amyl = starch) breaks down starch.

2.3n Urine and Other Miscellaneous Tests

Urinalysis

Ur/o is the word root for urine. Urine is a waste product created by the kidneys as the result of the body's metabolism; its production and excretion is needed to maintain a proper fluid and electrolyte balance. While urine contains many dissolved substances, 95% of urine is water. The amount of urine produced is approximately 1 liter a day.

Lipase (LIE-pace)
Any enzyme that breaks down fats

Amylase (AM-eh-lace)
Enzyme that breaks down starch into sugar

Besides taking images of the body or samples from the blood, another way to help diagnose certain conditions is with a **urine analysis** (UA). Your kidneys filter out waste products from your blood. Your physician can learn a lot of information from your urine by looking at the concentration, color, and odor of the sample. At least 10 milliliters (ml) are required for this test.

A **urinalysis** can test the urine's specific gravity and pH. The **specific gravity** (sg) indicates how well the kidneys can concentrate urine. Highly concentrated urine will contain less water and more dissolved materials and be darker yellow in color. Someone who is overhydrated will have a higher amount of water and clearer or less concentrated urine. The **urine pH** is the level of urine acidity. Some diseases can cause urine to become more acidic than normal.

Sometimes, urine can change from a clear fluid to a cloudy one; this ability to change clarity is referred to as urine's *turbidity*. Normal turbidity of urine ranges from clear to slightly hazy. Should the patient's urine become very cloudy, it may mean something is wrong. For example, cloudy urine can mean that there are bacteria present or other cells in the specimen. Urine should not contain any bacteria, so if there are bacteria present, it may be an indicator of a urinary tract infection. However, the cloudiness may also be caused by the body processing fatty or greasy foods. A culture of the urine sample would indicate if the cloudiness were due to bacteria.

Urine, like blood, can also be tested for the presence of sugar or glucose. A urine glucose test is used to determine if the patient has diabetes. If sugar is present in the urine, it is called **glycosuria** (glycos/o = sugar, -uria = urine) or **glucosuria** (glucos/o = glucose or sugar, -uria = urine). The normal urine glucose value is < 0.5 mg/dL; higher values would indicate diabetes.

Glucosuria (gloo-koh-SUE-ree-ah)
Excretion of sugar in the urine

Proteinuria (pro-teen-YOUR-ee-uh)
Excessive amount of protein in the urine

Proteins are not normally found in a urine sample of healthy patients because proteins are very large molecules that do not get through the kidney's filter and should therefore remain in the blood. If there are high levels of proteins found in a urine specimen, it is called **proteinuria** (-uria = urine); this may indicate that the patient has renal disease.

Urine odor can tip off a clinician as to whether a problem is occurring with their patient. Urine should not have a strong odor. However, if the patient has a urinary tract infection or is dehydrated, an odor can be present. You may have even encountered some offensive odors if you have eaten certain foods, like asparagus; this is entirely normal. Those with high levels of sugar in their blood will also urinate glucose to the point where it smells sweet. This is typically seen in diabetic patients.

Even urine color can be useful in reaching a diagnosis. See Table 2-8 for the different color variations of urine and their meanings.

Table 2-8 Urine Color and Meaning

Urine color	Potential meaning
Clear	Overly hydrated
Pale straw/light yellow	Normal
Darker amber/brown	Dehydration
Milky/cloudy	Excessive proteins or bacteria present
Brown/orange	Liver disease (orange can also be medication induced)
Pink/red	Blood/certain foods/cancer/medications/infections
Blue/green	Food dyes/medication/bacterial infections

Clinical Application 2–10

Optimal Sampling Time

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The best time to collect a urine sample for testing is in the morning, since it will be more likely to be concentrated and more likely to contain abnormalities. Sometimes you will hear the term "void," which can mean to urinate.

Febrile
The state of having an elevated temperature or fever

Splenomegaly (splee-noh-MEG-ah-lee)
Enlarged spleen

Hepatomegaly (hep-ah-toh-MEG-ah-lee)
Enlarged liver

Miscellaneous Common Tests

Mono Test

The **mononucleosis test** is a blood test used to detect the presence of a specific antibody produced by the body in response to the Epstein-Barr virus, which is in the herpes family. This is a contagious disease spread typically through saliva, which is why it was previously known as the "kissing disease." Some signs and symptoms that may present in an infected patient are: becoming **febrile** (having a fever), fatigue, and sore throat; in some cases, **splenomegaly** (splen/o = spleen, -megaly = enlarged) and **hepatomegaly** (hepat/o = liver, -megaly = enlarged) may occur.

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Strep Screen

A **strep screen** is done by swabbing the patient's throat. The results are provided within minutes. If positive, the patient has an infection caused by group A *streptococci*—a kind of bacteria. Remember, *strept/o* = chains and *-coccus* = sphere, so these bacteria would present as a chain of round spheres under the microscope.

Medical Checkup 2-3

1. Which of the following terms means blood?
   a. Erythr/o
   b. Hem/o
   c. Phleb/o
   d. Thromb/o

2. Which of the following terms means enlarged?
   a. -poises
   b. -blast
   c. -megaly
   d. -phage

3. Which of the following medical terms means too many red blood cells?
   a. Hematocrit
   b. Leukocytosis
   c. Polycythemia
   d. Leukemia

4. Which of the following terms mean deficiency?
   a. -emia
   b. -penia
   c. -osis
   d. -cytosis

5. Which of the following terms means excessive sugar in the blood?
   a. Erythrocytosis
   b. Anemia
   c. Glucose
   d. Hyperglycemia

6. Match the test to what it tests for.

____ CBC	a. Kidney
____ Pro time	b. Clotting
____ Lipid profile	c. Liver
____ BUN	d. Type and number of blood cells
____ ALP	e. Cholesterol

Chapter 2 Review

Review the following tables summarizing the key terms and abbreviations from this chapter. For each term or abbreviation you feel you know, check the corresponding checkbox. You can study the rest until all of them have been checked off.

Key Terms and Abbreviations

✓	Medical term	Meaning
☐	Adipose (ADD-ih-pohs)	Fat tissue
☐	Alanine (ALL-ah-neen) aminotransferase	Enzyme found in liver cells; high levels indicate liver damage
☐	Alkaline (AL-kuh-lin) phosphatase	Enzyme found in the liver as well as other tissues; high levels indicate likely bone or liver disease
☐	Amylase (AM-eh-lace)	Enzyme that breaks down starch into sugar
☐	Anemia (ah-NEE-mee-ah)	A lack of red blood cells
☐	Anteroposterior view	Used to describe an X-ray image taken when the X-ray machine is placed at the anterior, or front, of the patient and the film is located at the posterior, or back
☐	Aspartate (ah-SPAR-tate) aminotransferase	Enzyme found in cells in the heart and liver; high levels indicate liver or heart disease
☐	Basophil (BAY-soh-fill)	A type of WBC that increases in number in response to inflammation and blood disorders
☐	Bilirubin	Yellowish-orange substance formed when RBCs are destroyed
☐	Blood urea (YOUR-ree-ah) nitrogen	A blood test to determine the amount of urea nitrogen present in the blood
☐	Centrifuge	A piece of equipment used to spin liquid samples very quickly; can be used to separate blood into its components
☐	Cholesterol (koh-LES-ter-ol)	A fatty, wax-like substance found in the blood
☐	Complete blood count	A blood test ordered to measure many different components of the blood
☐	Comprehensive metabolic panel	A blood test used to measure the patient's electrolyte levels, glucose level, fluid balance, and kidney and liver function
☐	Computed tomography (toh-MOG-rah-fee) (CT)	Utilizes X-rays and a computer to create images of the body
☐	Contraindicated	When a certain diagnostic test or procedure should not be done
☐	Creatinine	A waste product produced by metabolism; high levels indicate kidney malfunction
☐	CT technologist	An individual who operates CT equipment to produce an image
☐	Cyanosis (sigh-ah-NOH-sis)	A bluish coloration of the skin and mucous membranes
☐	Differential leukocyte count	A WBC count that measures the percentage of WBCs in the blood

✓	Medical term	Meaning
☐	Electrolyte levels	Measurement of charged minerals within the blood, such as calcium and sodium, in milliequivalents per liter or milligrams per deciliter
☐	Eosinophil (ee-oh-SIN-oh-fill)	A type of WBC that increases in number in response to allergic reactions
☐	Erythroblast	Immature red blood cell
☐	Erythrocyte (eh-RITH-roh-sight)	Red blood cell
☐	Erythrocytosis (eh-RITH-roh-SIGH-toe-sis)	An abnormal or elevated number of red blood cells in the blood
☐	Erythropoiesis (eh-RITH-roh-poe-ee-sis)	Formation of red blood cells
☐	Erythropoietin (eh-RITH-roh-poy-et-in)	Hormone produced primarily by the kidneys to increase the production of red blood cells
☐	Febrile	The state of having an elevated temperature or fever
☐	Glucometer (gloo-KOHM-eh-ter)	A device used to monitor blood sugar levels
☐	Glucose	Sugar
☐	Glucosuria (gloo-koh-SUE-ree-ah)	Excretion of sugar in the urine
☐	Glycated hemoglobin	Hemoglobin bound with glucose
☐	Glycosuria (gly-koh-SUE-ree-ah)	Excretion of sugar in the urine
☐	Gram	Metric unit measuring weight (or mass)
☐	Granulocyte (gran-YOU-low-site)	A type of WBC that contains granules
☐	Hematocrit (hee-MAT-oh-krit)	A blood test used to see how many blood cells are in the plasma
☐	Hematology (hee-mah-TOL-oh-gee)	A branch of medicine that studies the blood
☐	Hemoglobin	Protein in the blood responsible for transporting oxygen
☐	Hepatomegaly (hep-ah-toh-MEG-ah-lee)	Enlarged liver
☐	High-density lipoprotein	A waxy, fatty substance that is the “good” cholesterol that helps clean the vessels of LDL
☐	Hyperbilirubinemia	Excessive amount of bilirubin in the blood
☐	Hypercalcemia	Excessive amount of calcium in the blood
☐	Hyperchloremia	Excessive amount of chloride in the blood
☐	Hyperglycemia	Excessive amount of sugar in the blood
☐	Hyperkalemia	Excessive amount of potassium in the blood
☐	Hypermagnesemia	Excessive amount of magnesium in the blood
☐	Hypernatremia	Excessive amount of sodium in the blood
☐	Hyperphosphatemia	Excessive amount of phosphate in the blood
☐	Hypocalcemia	Below normal amount of calcium in the blood
☐	Hypochloremia	Below normal amount of chloride in the blood

✓	Medical term	Meaning
☐	Hypoglycemia (HI-po-gly-SEE-me-ah)	Below normal amount of sugar in the blood
☐	Hypokalemia	Below normal amount of potassium in the blood
☐	Hypomagnesemia	Below normal amount of magnesium in the blood
☐	Hyponatremia	Below normal amount of sodium in the blood
☐	Hypophosphatemia	Below normal amount of phosphate in the blood
☐	Jaundice (JAWN-dis)	Yellow coloration of the skin due to excessive levels of bilirubin in the blood
☐	Lateral view	Used to describe when the X-ray machine is directed at a patient's side, and the film or detector is placed at the opposite side
☐	Leukemia (loo-KEE-mee-ah)	A cancer of the blood
☐	Leukocyte (LOO-koh-sight)	White blood cell
☐	Leukocytosis	High level of white blood cells in the blood
☐	Leukopenia (loo-koh-PEE-nee-a)	Abnormally low count of WBCs
☐	Lipase (LIE-pace)	Any enzyme that breaks down fats
☐	Lipid profile	A panel of blood tests used to look for abnormal levels of lipids, or fats, such as cholesterol and triglycerides, in the blood
☐	Liter	Metric unit measuring volume
☐	Low-density lipoprotein	A waxy, fatty substance that is the "bad" cholesterol that can build up in vessels, causing blockages
☐	Lymphocyte (LIM-foh-sight)	Immune system cell that is found in lymph nodes
☐	Macrophage (MACK-roh-fayj)	A type of WBC that engulfs cellular debris
☐	Magnetic resonance imaging	An imaging procedure that utilizes strong magnetic fields to obtain detailed images of the body
☐	Meter	Metric unit measuring length
☐	Monocyte	A type of WBC that can increase in number in the presence of a severe or chronic infection
☐	Mononuclear leukocytes	A group of WBCs that have one nucleus
☐	Mononucleosis test	A blood test that is used to determine the presence of antibodies that indicate mononucleosis
☐	MRI technologist	A radiology technologist who specializes in magnetic resonance imaging
☐	Neutrophil (NEW-troh-fill)	A type of WBC that increases in number in response to bacterial infections, inflammation, and stress
☐	Nuclear medicine	A medical specialty that utilizes radioactive substances for diagnostic and therapeutic purposes
☐	Nuclear medicine technologist	An individual who prepares and administers radioactive drugs for diagnostic imaging or therapeutic purposes

✓	Medical term	Meaning
☐	Oblique view	Used to describe an X-ray taken at an angle
☐	Phagocyte (FAG-oh-sight)	A type of WBC that engulfs foreign debris from the body
☐	Phlebotomist (fleh-BOT-oh-mist)	Someone who specializes in collecting blood samples
☐	Plasma	The yellowish liquid portion of the blood that contains the components of the blood
☐	Polycythemia (paul-ee-sigh-THEE-mee-ah)	Caused by a disease state where the body produces too many red blood cells
☐	Polymorphonuclear leukocytes	A group of WBCs that contain many different shaped nuclei
☐	Positron emission tomography	A type of nuclear medicine imaging that uses a tracer to help determine how the body metabolizes and functions
☐	Posteroanterior view	Used to describe an X-ray image taken when the X-ray machine is placed at the posterior, or back, and the film is located at the anterior, or front, of the patient
☐	Proteinuria (pro-teen-YOUR-ee-uh)	Excessive amount of protein in the urine
☐	Prothrombin time	A diagnostic test used to determine the presence of an excessive clotting or bleeding disorder
☐	Radiologist	A medical doctor specializing in diagnosing and treating injuries and diseases using medical imaging
☐	Radiology	Medical profession utilizing medical imaging to treat and diagnose conditions of the body
☐	Radiology technologist	Profession that assures quality diagnostic imaging is produced
☐	Radiopharmaceutical	A radioactive substance used for diagnostic or therapeutic purposes
☐	Sonographer (soh-NOH-graf-er)	The individual performing a sonogram or ultrasound
☐	Sonography (son-OG-rah-fee)	The process of recording a sonogram or ultrasound
☐	Specific gravity of urine	A test used to compare the density of urine to the density of water to determine how well the kidneys can concentrate urine
☐	Splenomegaly (splee-noh-MEG-ah-lee)	Enlarged spleen
☐	Strep screen	A swab test used to detect the presence of group A *streptococci* in the back of the throat
☐	Thrombocyte (THROM-boh-sight)	Clotting cell, also known as a platelet
☐	Thrombocytopenia (throm-boh-sigh-toh-PEE-nee-ah)	Less than normal number of platelets in the blood
☐	Thrombocytosis (throm-boh-sigh-TOH-sis)	Excessive number of platelets found in the blood
☐	Triglyceride (tri-GLISS-er-ides)	A type of fat or lipid found in the blood
☐	Ultrasound	Medical imaging that utilizes high-frequency sounds to produce an image; also known as sonography

✓	Medical term	Meaning
☐	Urinary tract infection	Infection of the urinary tract, which includes any part of the urinary system, such as the bladder, urethra, and kidneys
☐	Urine analysis, urinalysis	Testing the urine for certain disorders
☐	Urine odor	Test used to detect certain conditions
☐	Urine pH	Testing the chemistry of the urine to determine whether it is acidic or alkaline
☐	Xanthemia (zan-THEE-mee-ah)	A condition where the skin turns a yellow color
☐	X-ray	A two-dimensional radiologic image

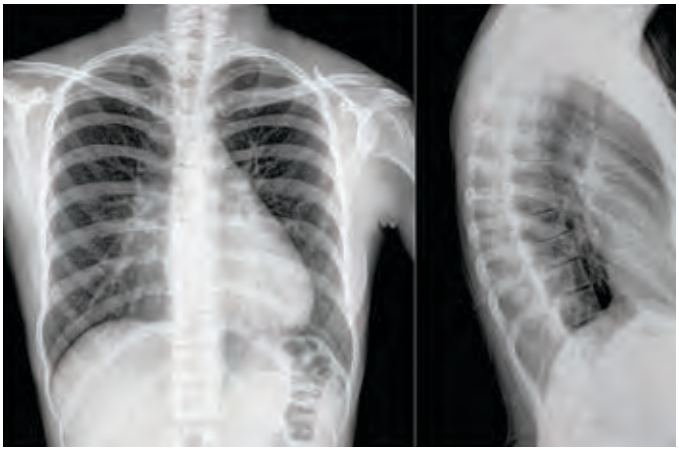
Abbreviations

The following table contains the key medical abbreviations that appeared in this chapter. Please note that there may be regional differences in what abbreviations are used and some of these abbreviations may not be used at all health care facilities. Additionally, some abbreviations may conflict with other abbreviations that carry other meanings (eg, pt for patient and PT for physical therapy). When in doubt, write out what you mean rather than using an abbreviation that may introduce confusion.

✓	Medical abbreviation	Meaning
☐	A1c	Glycated hemoglobin
☐	ALP	Alkaline phosphatase
☐	ALT	Alanine aminotransferase
☐	AP	Anteroposterior view
☐	AST	Aspartate aminotransferase
☐	BUN or SUN	Blood urea nitrogen; also known as serum urea nitrogen
☐	c	Centi-
☐	C&S	Culture and sensitivity
☐	Ca	Chemical symbol for calcium
☐	CBC	Complete blood (cell) count
☐	Cl^-	Chemical symbol for chloride
☐	CMP	Comprehensive metabolic panel
☐	CT	Computed tomography
☐	CXR	Chest X-ray
☐	d	Deci-
☐	da	Deca-
☐	Diff	Differential leukocyte count
☐	g	Gram
☐	h	Hecto-

✓	Medical abbreviation	Meaning
☐	HCT	Hematocrit (this abbreviation should be avoided because of the possibility of confusion with hydrocortisone and hydrochlorothiazide; when in doubt, write it out)
☐	HDL	High-density lipoprotein
☐	Hgb	Hemoglobin
☐	k	Kilo-
☐	K^+	Potassium ion
☐	L	Liter
☐	LDL	Low-density lipoprotein
☐	m	Meter
☐	m	Milli-
☐	Mg	Chemical symbol for magnesium
☐	MRI	Magnetic resonance imaging
☐	Na^+	Sodium ion
☐	PA	Posteroanterior view
☐	PET	Positron emission tomography
☐	PLT	Platelets
☐	PO_4	Phosphate
☐	PT	Prothrombin time
☐	RBC	Red blood cell
☐	sg	Specific gravity
☐	UA	Urine analysis, urinalysis
☐	UTI	Urinary tract infection
☐	WBC	White blood cell

Medical Exam 2



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Patient X-Ray

Case No. 2.1

60-year-old Luis Salazar was working on his farm and noticed some shortness of breath, a productive cough, dizziness, and weakness. He has a personal history of hepatomegaly and a strong family history of diabetes. The physician orders the following image test.

1. Give the correct abbreviation for the type of image.
   a. MRI
   b. PET Scan
   c. Ultrasound
   d. CXR
2. The second image represents a(n) ____ view of the chest, or thorax.
   a. AP
   b. PA
   c. lateral
   d. superior
3. The darker areas on the image represent _____ densities and are most likely _____.
   a. radiolucent, air
   b. radiopaque, air
   c. radiolucent, bone
   d. radiopaque, bone
4. The doctor determines that the lungs are clear and decides to get a more detailed image to assess the hepatomegaly. The imaging chosen would be a(n) _____ and would focus in on the _____.
   a. X-ray, liver
   b. MRI, kidney
   c. CT, kidney
   d. MRI, liver
5. The doctor also orders a glucose test, an A1c test, and electrolyte studies. The results are hyperglycemia, a high A1c, and hypokalemia and hyponatremia. The results could best be described as _____.
   a. high blood sugar, low chloride, and low potassium
   b. low blood sugar, low potassium, and low sodium
   c. high blood sugar, low potassium, and low magnesium
   d. high blood sugar, low potassium, and low sodium

6. The units of measure for the electrolytes are _____.

   a. mL
   b. mcg
   c. grams
   d. mEq

7. An IV is ordered for Luis to infuse 0.5 liters of a solution containing potassium. How many milliliters of this solution should be administered?

   a. 500 mL
   b. 5 mL
   c. 50 000 mL
   d. 0.5 mL

8. Luis is given a glucometer for home use. This device will test his _____.

   a. liver enzymes
   b. cholesterol
   c. blood sugar
   d. triglycerides

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Case No. 2.2

Lucy Johnson is 18 weeks pregnant when she notices while doing her makeup that she has a yellowish tint to the whites of her eyes. She hasn't been feeling well but had chalked it up to nausea that she'd heard often comes with pregnancy. She calls her doctor, who tells her to come in immediately for testing.

1. What imaging test would be most appropriate to assess the health of the baby?

   a. CT scan
   b. X-ray
   c. Sonography
   d. Interventional radiography

2. The yellowish color in her eyes is found to be due to a buildup of bilirubin in her bloodstream. This condition is known as _____ and the technical medical term for the coloration of the blood is _____.

   a. jaundice, cyanosis
   b. jaundice, xanthemia
   c. polycythemia, xanthemia
   d. polycythemia, cyanosis

3. The doctor tells her the baby is fine, but she is concerned with the levels of fats in her bloodstream and how well her kidneys are functioning. The test to check the levels of "fatty" substances in her blood is a _____.

   a. CBC
   b. lipid profile
   c. liver enzyme
   d. culture and sensitivity

4. The tests confirm hypercholesteremia and a high SUN. These results can best be described as _____.
   a. high levels of cholesterol and high serum urine nodules
   b. low levels of cholesterol and high serum urea nitrogen
   c. high levels of cholesterol and high serum urea nitrogen
   d. normal levels of cholesterol and high serum urea nitrogen
5. Lucy is given a strict diet with the goal of increasing her _____ and decreasing her _____.
   a. HDL, LDL
   b. LDL, HDL
   c. LDL, SUN
   d. SUN, HDL


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Case No. 2.3

Charles Rayford was diagnosed with chronic lung disease at age 59 due to 40 pack years of smoking. He quit smoking at age 59 but is now 70 and the disease has progressed. He especially has a difficult time breathing in the winter months and is more susceptible to pneumonias during this time. At a routine visit to his PCP, he complains of shortness of breath and a productive cough; the physician notes perioral cyanosis. Charles also states he has been getting up to urinate more often at night. The doctor orders a CBC; it shows RBC polycythemia, leukocytosis, and thrombocytopenia. In addition, he orders a urinalysis; it shows a UTI.

1. The doctor noted a _____ color on Charles's _____.
   a. yellowish, lips
   b. bluish, nose
   c. bluish, lips
   d. bluish, arms
2. What best describes the CBC results?
   a. High levels of RBCs and WBCs
   b. Low levels of RBCs and WBCs
   c. High levels of RBCs and low levels of WBCs
   d. Normal cellular counts
3. What two specialists would the PCP consider sending Charles to, given his current condition?
   a. Cardiologist, urologist
   b. Pulmonologist, sonographer
   c. Dermatologist, pulmonologist
   d. Pulmonologist, urologist
4. Leukocytosis might suggest he has _____.
   a. diabetes
   b. anemia
   c. polycythemia
   d. an infection

5. The physician is concerned about him bleeding to death because of what test result?

   a. Leukocytosis
   b. Polycythemia
   c. UTI
   d. Thrombocytopenia

6. A culture and sensitivity test is ordered on a sputum sample; it is found that Charles has streptococcal pneumonia. An antibiotic is prescribed at 5 milligrams per kilograms. Charles weighs 165 pounds. How much antibiotic should he get?

   a. 75 mg
   b. 375 mg
   c. 1800 mg
   d. 10 mg

Medical Checkup Answers

2-1 (1) b, c, a, (2) c, (3) a, (4) b, a, d, c, (5) b

2-2 (1) b, (2) b, (3) b, (4) d, (5) e, d, c, a, b

2-3 (1) b, (2) c, (3) c, (4) b, (5) d, (6) d, b, e, a, c