LAB AREAS & FUNCTIONS

The clinical laboratory may be in one location or may be decentralized in a variety of locations in the hospital. These include the main laboratory, ambulatory care laboratory (outpatient laboratory), stat laboratory, and surgery laboratory. Each laboratory serves a specific function and often has sections within it.

The main laboratory is the largest laboratory. The office section of the main laboratory receives and routes laboratory-related telephone calls, specimen collection requests, and some specimens.

In close proximity to the office is the area of specimen collection, more commonly known as **phlebotomy**. From there the phlebotomists are dispatched to collect blood samples from patients throughout the hospital. The patients are most familiar with this section because **often the phlebotomist is the only representative from the laboratory the patient sees.** Once collected, the specimens go to any one of the laboratories within the hospital.

The **hematology** staff studies blood cells and performs qualitative and quantitative analyses along with microscopic examinations. The CBC, or complete blood cell count, is a routine test, providing the physician with a large amount of valuable information about a patient's state of health.

Coagulation is usually in the same area as hematology. Coagulation is the study of blood clotting mechanisms. Staff from this section monitor patients on anticoagulant therapy and test patients with bleeding disorders and presurgical patients.

Staff in the **urinalysis** section perform qualitative and quantitative chemical and microscopic examinations of urine to detect urinary tract infections, diabetes, and liver or kidney diseases. Urinalysis is often performed in or near the same area as hematology in order to share microscopes.

The **chemistry** section works with the fluid portion of the blood, the serum or plasma, or other body fluids.

- The staff perform biochemical analysis of blood and body fluids by manual or automated techniques. A variety of instruments analyze for chemicals such as glucose, electrolytes, blood urea nitrogen (BUN), and creatinine.

- With almost all instruments, the sample is added to various chemicals and a color develops. For example, the more glucose in the blood, the darker the color. In addition to single tests, instruments often run multiple tests on one sample. The panel, a battery of several tests performed on one sample, is a quick method to screen patients for illness.

Special chemistry is a subsection of chemistry whose staff perform more sophisticated and time-consuming procedures. Examples of these tests are protein electrophoresis, thyroid studies, and aminoglycoside levels.

Microbiology studies organisms that are so small they can only be seen with the aid of a microscope. There the technologist identifies aerobic and anaerobic bacteria, fungi, mycobacteria (such as tuberculosis), and parasites.

- Specimens brought to this area include throat cultures, urine cultures, wound and skin cultures, blood cultures, and other types of cultures.

- Once the organism that is causing the problem is determined, a test called a sensitivity is run to determine what antibiotic would be best to eliminate the problem organism.

The **immunology** section studies antigen–antibody reactions. Antigens are substances seen as being "foreign" in the body, and antibodies are proteins made by the body to combat specific antigens.

Staff in this section perform tests to detect and evaluate HIV (human immunodeficiency virus), hepatitis, mononu- cleosis, rheumatoid arthritis, and syphilis, and they also perform fluorescent antibody tests.

The blood bank section (sometimes called **immunohematology**) studies antigens and antibodies as they relate to the red blood cells. This section performs blood typing, crossmatching/compatibility testing, and screening for antibodies. The
primary testing is to determine compatibility of blood from a donor with a recipient.

- This crossmatching of donor to recipient determines if the blood that the recipient will receive is compatible.

- Proper patient identification is critical when the blood the phlebotomist draws will be used to determine a product that will be infused into a patient.

- A misidentification of a patient opens the possibility that the patient will receive the wrong type of blood, with serious complications to the patient. The complications can range from fever to death by kidney failure.

- Few hospitals draw their own donors. Most hospitals procure the blood they transfuse from a central donor facility, such as the Red Cross or local blood centers.

- Other products that the blood bank issues to patients are platelets and cryoprecipitate.

Cytogenetics is an area found in some of the larger laboratories. This section studies deficiencies that are related to genetic diseases. Genetic testing is expanding rapidly.

- The area of **cytology and histology** (also known as **pathology**) examines tissues and cell smears for evidence of cancer, infection, or other abnormalities.

- All tissue biopsy specimens, surgical specimens obtained in surgery, or tissues obtained in minor surgeries at a physician's office are submitted there for examination.

- The cytology specimens are processed and then examined microscopically by a cyto- technologist. The majority of the cytology specimens are Pap tests.
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- The surgery specimens are prepared by a histologist and then examined macroscopically and microscopically by the pathologist.

The **stat laboratory** handles stat (emergency) requests.

- It is staffed twenty-four hours a day, seven days a week.

- The stat laboratory can do many of the same tests done in the main laboratory, but does these tests individually and not in a batch mode (large groups together), as is often done in the main laboratory.

- It also provides a backup system for the main laboratory in case of instrument malfunctions.

Near the outpatient entrance of some hospitals, the **ambulatory care laboratory** (**outpatient laboratory**) is found.

- It provides rapid turnaround of results on frequently ordered tests for outpatients.

- It also has an active marketing and outreach program that includes services for nursing homes, physicians' offices, and health screening for businesses.

Even with the elaborate testing facilities available in most laboratories, outside lab- oratories are often needed to do specialized testing. These **reference laboratories** can be in the same city or many miles away. The specimens are transported to the reference laboratory each evening, and results are sent back via computer and tele- phone lines the next morning.

All these laboratory areas are involved in the goal of the laboratory, which is to get results on the patient's condition to the physician. This encompasses **three phases** of specimen testing: **preanalytical, analytical, and postanalytical**.

Preanalytical—All processes that it takes to collect the specimen and get it to the point in which the testing of the specimen can occur. These include the following:

- Patient identification and information
- Correct specimen collection
- Correct primary sample identification
- Correct use of all equipment
- Sample preparation or centrifugation
- Proper preparation of sample aliquots
- Maintaining specimen integrity until testing can be completed

Analytical—All processes that are done to perform the test on the specimen to achieve a result. This phase includes the following:
- Specimen testing
- Maintaining testing equipment and reagents

Postanalytical—The process whereby the results of the testing are communicated to the physician. This phase consists of the following:

- Reporting of results
- Assuring accuracy and reliability of delivery of results
- Follow-up to repeat testing or address physician concerns

The phlebotomist is mainly involved in the preanalytical phase of specimen testing.

- The primary duty of the phlebotomist is to collect venous blood specimens from patients.

- Once the sample is collected, it is prepared by the phlebotomist through centrifugation and processing of the specimen to make it stable until testing can occur.

- The first step of patient identification in the preanalytical process is the most important step in the process.

- Correct patient identification is critical to ensure that the remaining phases produce accurate results.

- Improperly identifying the patient is a common clerical error in the process.

Hospital Areas and Type of Care

Coronary Care Unit (CCU)—Increased care of the patient due to a heart condition

Emergency Department—Emergency treatment of patients

Geriatric—Elderly patients

Home Health Care—Follow-up care of a patient at home

Intensive Care Unit (ICU)—Increased care due to the critical needs of the patient

Neonatal—Newborn care

Nephrology—Dialysis patients

Obstetrics—Patients in labor of childbirth

Oncology—Cancer patients

Orthopedic—Patients with broken bones

Pediatrics—Infants and children

Recovery—Recovery treatment of patients

Areas of the Hospital and Health Care Setting

The phlebotomist will work in diverse health care settings and with all levels of individuals, from the physician with several advanced degrees to support staff with little education.

- Whatever the level of education or responsibility each individual has, the phlebotomist must maintain professionalism.

- Patients will also range from the highly educated to individuals who have mental deficiencies.

- Each one of these individuals is a customer of the phlebotomist and laboratory.

- The phlebotomist is the "laboratory representative" because the phlebotomist is the person from the lab- oratory that most health care staff and patients have contact with.

- Phlebotomists must be familiar with the organization to function in this complex health care field. They usually work directly with the laboratory but indirectly with nurses, physicians, and the staff in the radiology, pharmacy, and physical therapy departments. Many people from different departments need time with the patient. To be better capable of working together, it is best to understand a little about each area.

- The phlebotomist often encounters staff from the electrocardiography department. This department does electrocardiograms (abbreviated EKG). An EKG is a record- ing of impulses of the heart. Impulses from a normal heart make tracing records of a specific size and shape. The abnormal heart shows changes that are different from this pattern. These EKGs are performed in the patient's room, and the phlebotomist often waits for the test to be completed to draw blood.

- Another staff member who may visit the patient's room is from the electroen- cephalography department. This department does electroencephalograms (EEGs), which record the electrical activity of the brain. EEGs help locate and assess the ex- tent of brain injury or determine if there is any brain activity.

The pharmacy department of the hospital is much different from the corner drug- store.

The hospital pharmacy dispenses many types of therapeutic drugs that often are much more potent than a prescription taken at home. These drugs are prescribed and monitored under controlled conditions while the patient is in the hospital.

The phlebotomist plays an integral part in this monitoring through the blood samples that are collected at specific times. With the results of the samples, the pharmacist is able to consult with the laboratory and the patient's physician.

The physical therapy department works with patients who due to disease or injury are no longer able to function to their full physical capacity.

The therapy may involve rebuilding deteriorated muscles after a long illness or learning to function after an amputation.

Related to physical therapy is the department of occupational therapy, where patients work to overcome their physical handicaps so they can be productive again in their old job or function in a new job.

Speech therapy is another area related to physical therapy. Patients who have difficulty speaking or who have lost their ability to speak because of a stroke or disease are retaught how to speak.

Radiology is an area of the hospital that has changed rapidly in recent years. Radiologists used to just x-ray lungs or broken bones. But the field has expanded to include cardiac catheterization, CT scans (computed tomography), MRI (magnetic resonance imaging), and ultrasound.

Each of these techniques has become a sub-specialty of radiology that still looks into the body as the traditional x-ray did, but in a much more detailed and sophisticated way.

The largest department the phlebotomist works with is the department of nursing. Phlebotomists work closely with many of the nurses to give the best care to patients.

Phlebotomists may need to ask nurses for assistance with patients who are unwilling to hold still or to check with them about the proper time to draw a specimen.

The ability to work with other departments of the hospital is a key trait of the best phlebotomists.

The phlebotomist who is well liked and cooperates with others for the patients' care is the one who will earn cooperation from other individuals.

Laboratory Sections and Their Function/Purpose

Administrative Office—Responds to telephone calls, handles specimen collection requests and
some specimens

Phlebotomy (Specimen Collection)—Collects specimens from patients and processes specimens for testing or transport

Hematology—Studies the blood in normal and diseased states. Usually limited to the study of cellular components and not the chemistry of blood
Examples of Tests: Complete blood cell count (CBC), hemoglobin, hematocrit, platelet count, sedimentation rate, body fluid cell counts

Coagulation—Study of blood clotting mechanisms as an aid in diagnosis or monitoring of patient therapy
Examples of Tests: Prothrombin time (PT), activated partial thromboplastin time (aPTT), D-dimer, factor VIII, fibrinogen assay, heparin level, von Willebrand factor (ristocetin)

Urinalysis—Study of urine to aid in patient diagnosis to follow the course of a disease or the body's metabolism
Examples of Tests: Urinalysis, reducing substance, urine Ph, urine glucose

Chemistry—Performs biochemical analysis of blood and body fluids to determine the status of a patient
Examples of Tests: Comprehensive metabolic panel, iron studies, renal panel, Carcinoembryonic Antigen (CEA), glucose, alanine aminotransferase (ALT), aspartate aminotransferase (AST), Cholesterol

Microbiology—Cultures specimens to determine if pathogenic organisms are present in a sample and determines the organisms' sensitivity to antibiotics (culture and sensitivity)
Examples of Tests: Blood cultures, throat cultures, anaerobic cultures, urine cultures, parasite identification, stool culture, mycobacterial (tuberculosis) culture, virus cultures, fungal cultures, genital cultures, mycoplasma cultures, antibiotic susceptibility testing

Immunology—Studies antigens and antibodies to determine immunity to disease or presence of disease
Examples of Tests: Human immunodeficiency virus (HIV) testing, rubella, syphilis (rapid plasma reagin [RPR]), hepatitis testing

Immunohematology (Blood Bank)—Determines compatibility of blood and blood products that are to be administered to patients

Examples of Tests: Compatibility testing, antibody screens or ABO, Rh determination

Cytogenetics—Study of deficiencies related to genetic diseases Examples of Tests: Chromosomes analysis, prenatal chromosome screening

Laboratory Staff

The staff working in the laboratory have a large range of duties and training result- ing in numerous job titles and roles. The technical positions are either four-year degree positions or two-year associate degree positions. A technologist has a bachelor's degree and a medical technology or clinical laboratory scientist certification.

A technician has a two-year associate degree in medical technology and a certifica- tion. Both roles are needed to make a laboratory run smoothly and efficiently. The secretarial or clerical positions in the office areas of the laboratory require a high school education and some secretarial/clerical training. A knowledge of medical ter- minology is helpful. The laboratory staff is made up of a wide range of individuals with varying degrees and experience (Figure 1.5).

The medical laboratory technician, also called a clinical laboratory technician, is a graduate of a two-year associate degree program. This program is taken through a college or proprietary school that is affiliated with a health care center. The health care center provides the practical experience. Once the training is completed, the student must take a certification or registry exam. Some states also have a licensing requirement. Upon successful passing of the certification exam, the technicians are certified as either an MLT (medical laboratory technician) or CLT (clinical labora- tory technician).
Another two-year associate degree program that includes at least one year of clini- cal experience is the histologic technician (HT). The histologic technician prepares the tissue samples for microscopic examination in the histology section of the lab- oratory. A person who has completed a baccalaureate degree program in histology and has a year of histopathology experience will qualify to take the certification exam for histotechnologist.

A section related to histology is cytology. In this section a person with a baccalau- reate degree and completion of a 12-month accredited cytotechnology program is then eligible to take a certification exam to qualify as a CT (cytotechnologist).

Working in the laboratory as a medical technologist or Clinical Laboratory Scientist requires a baccalaureate degree. This degree involves attending an approved uni- versity for three or four years and then spending a full 12 months training in an ac- credited laboratory. The laboratory portion is equally divided between lectures and working in the laboratory. Once completed, the person may take a certification exam to become an MT (medical technologist). The medical technologist can advance to a supervisor, manager, or administrative director position. The require- ments needed to work in a laboratory vary by state.

The person in the laboratory with the most education is the pathologist. The patholo- gist is a physician who has completed additional schooling and an internship to spe- cialize in pathology. This is a physician specialty, like pediatrics or surgery. The pathol- ogist is sometimes called the doctor's doctor. The physicians within the hospital consult with the pathologist on disease processes they see in a patient. The physicians also con- fer with the pathologist to determine if additional tests need to be run on a patient to confirm a particular disease process. The pathologist directs the test protocols and test procedures that are done in the laboratory. He or she

does extensive consultation on surgical or autopsy specimens, bone marrow procedures, and cytology specimens.

Ancillary Hospital Areas and Their Purpose

Administration—Keeps the hospital in compliance

Electrocardiography (EKG)—Monitors cardiovascular patients

Electroencephalography (EEG)—Diagnosis of neurophysiological disorders

Environmental Services—Maintains a clean facility

Food Service (Dietary)—Provides diets to patients

Gastrointestinal (GI) Lab—Diagnoses gastrointestinal disorders

Laboratory—Provides testing of patient specimens
Medical Records—Maintains patient records

Nursing—Provides direct patient care

Occupational Therapy—Provides therapy to help maintain living skills

Pharmacy—Dispenses drugs and advises on drug usage

Physical Therapy—Provides therapy to restore mobility

Radiology—Uses imaging for diagnosis and treatment

Respiratory Therapy—Provides therapy to evaluate the lungs

Speech Therapy—Provides therapy to restore speech

Clinical Chemistry is the largest laboratory department.

Through chemical analysis of serum or plasma many diseases of the major organs systems can be diagnosed such as heart attacks, hepatitis, renal failure, diabetes, etc. (**Drawn in red, gold or green stoppered tube**)
Perform chemical analyses on serum and plasma.

Blood **lipids** (fat) such as cholesterol and triglycerides to diagnose risk of heart disease.
Iron and total iron binding capacity to diagnose anemia.

Electrolytes - sodium, potassium, CO2 and chloride become abnormal in dehydrated
patients.

Uric acid - indication of renal function or gout.

Creatinine and Blood Urea Nitrogen (BUN) used to monitor kidney function.

Liver function tests (also called LFTs) include AST, ALT, alkaline phosphatase, LDH, and bilirubin.

Cardiac enzymes -CK, ALT, LDH along with electrolytes aid in the diagnosis of heart
attack.

Amylase and lipase levels aid in the diagnosis of acute pancreatitis.

Glucose to diagnose and monitor diabetes. (**May use gray stoppered tube**)

Hormones such as thyroxine (T4), parathyroid hormone, insulin, testosterone, renin activity,
luteinizing hormone, prolactin, and cortisol.

Drug analysis is of two types:
1) Therapeutic drug monitoring (TDM) to ensure patient is maintaining therapeutic blood levels of drugs such as gentamycin, dilantin, tobramycin, digoxin,etc.
2) Drugs of abuse testing to detect blood alcohol, barbiturates, salicylates, etc.

Special chemistry deals with analysis of rare or uncommon substances.
Immunoassay which includes the techniques of radioimmunoassay (RIA) and enzyme
immunoassay (EIA).

Chemistry profiles are very popular and include a menu of commonly ordered chemistry
tests selected to evaluate each major organ system.

Hematology is the study of the formed elements of the blood to identify diseases associated with blood and blood forming tissues.

Hematology tests aid the physician in diagnosing infections, leukemia, polycythemia,
anemia and other blood abnormalities.

The most commonly ordered hematology test is the complete blood count (CBC) which is
routinely performed on automated instruments, such as the Coulter counter, that electronically count the cells and calculate results.

CBC is actually a multi-part assay which includes the following (purple stoppered tube):
1) hematocrit (HCT)
2) hemoglobin (HGB)
3) red blood cell (RBC) count
4) white blood cell (WBC) count
5) platelet count
6) mean corpuscular hemoglobin (MCH)
7) mean corpuscular hemoglobin concentration (MCHC)
8) mean corpuscular volume (MCV)
9) differential (DIFF)-done on a blood smear.

Other tests performed in the hematology department include:
1) reticulocyte count (purple)
2) erythrocyte sedimentation rate (ESR or Sed Rate) (purple or black)
3) sickle cell preparation (purple)
4) Eosinophil count (purple)
5) Cell counts and differential on body fluids such as: CSF, pleural, synovial, and pericardial.

Coagulation department is often housed in the hematology area.

Coagulation deals with the study of defects in the blood clotting mechanism and monitoring of medication given to patients as "blood thinners" or anticoagulant therapy.

Blood for the following tests is always collected in light blue stoppered tubes.
1) Prothrombin time (PT)
2) Partial thromboplastin time (PTT)

3) Fibrinogen
4) Fibrin split products or fibrin degradation products (FDP)

Urinalysis department is often housed in the hematology area also.
Urinalysis is a routine test performed on urine that involves chemical tests to screen for substances which may indicate disease or damage.
UA dipstick will detect abnormalities or the presence of the following - pH, specific gravity, protein, glucose, bilirubin, urobilinogen, nitrites, leukocytes, occult blood, and ketones.

The urine is centrifuged, decanted and the small portion that is left is examined for the presence and number of the following - yeast, bacteria, WBCs, RBCs, mucous, epithelial cells, crystals and parasites.

Pregnancy tests are performed in this department also.
Cultures (UA C&S) are commonly ordered on urine. The urine must be taken to the microbiology department first for processing.

Microbiology is the department that analyzes body fluids and tissues for the presence of pathogenic microorganisms primarily by means of culture and sensitivity (C&S).
Results of the C&S tell the physician the type of organisms present as well as the particular antibiotic that would be most effective for treatment.

Collecting and transporting microbiology specimens is very important in the identification of microorganisms and must be handled with great care.

Subsections of microbiology include bacteriology (study of bacteria), parasitology (study of parasites), mycology (study of fungi), and virology (study of viruses).

Tests frequently ordered include the following:
1) Acid-fast bacilli (AFB) smear
2) AFB culture
3) fungus direct smear
4) Culture and sensitivity
5) Gram stain
6) GC (gonococcal) culture (tests for gonorrhea)
7) Pinworm prep
8) Ova and parasite (O&P)
9) Occult blood
10) Strep screen
11) fungus culture
12) throat culture
13) urine culture
14) blood culture

15) fecal culture

Serology or immunology - serology literally means the study of serum.

Tests done in this department are designed to detect the body's response to the presence of bacterial, viral, fungal, parasitic and other conditions which stimulate detectable antigen- antibody reactions in a test system to aid in the diagnosis of the patient.

The following tests may be performed in the Serology department (red stoppered tube):

1) Cold agglutinins (CAG) - **specimen must be kept warm**.
2) Anti-streptolysin O titer (ASO) or screen such as Streptozyme
3) Infectious Mononucleosis (IM) tests such as Monospot
4) Rheumatoid arthritis (RA)
5) VDRL, RPR or FTABS to diagnose syphilis
6) Haptoglobin (HP)
7) Rubella
8) Pregnancy Testing
9) C-Reactive Protein (CRP)

Immunohematology (Blood Bank) performs tests to provide blood and blood products to patients for transfusion purposes.

The blood bank technologist relies on the phlebotomist to perform identification of the patient **without error**, since patients will die if given the wrong blood type.

Stopper color:
1)Plain red NO GEL for labs using tube testing.
2)Pink stopper for labs using the gel testing system.
3)The only exception is the Direct Antiglobulin test which is drawn into a purple top.

Tests include the following:
1) ABO/D (Rh) typing
2) Antibody screen AKA indirect antiglobulin test (IAT).
3) Type and Screen (T&S)
4) Crossmatch
5) Direct Antiglobulin Test (DAT or DC)
6) Rh Immune Globulin (RHIG) or Rhogam workup
7) Antibody titer
8) Antigen typing
9) Antibody Identification

Requests for components such as RBCs, platelets, cryoprecipitate (CRYO) and fresh frozen plasma (FFP) will be delivered to the blood bank.

Anatomic and surgical pathology include the following departments:

Cytology - processes body fluids and other tissue specimens for detection and diagnostic interpretation of cell changes that might indicate cancer, ie, PAP smears.

Histology - prepares and process tissue samples removed during surgery, autopsy or other medical procedures for microscopic examination and evaluation by a pathologist.

Cytogenetics - provides detailed study of individual chromosomes that can detect genetic or acquired diseases or disorders.

DNA probe analysis tests for genetic disorders, malignant disorders, infections, pathogens and DNA fingerprinting in forensic medicine.

Education and research - develops new procedures as well as basic research contributing to clinical laboratory sciences.
Performed by pathologists, Phds and Medical technologists. b.

Generally done in large teaching hospitals with affiliations with a large university.