Phlebotomy Course Manual

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Chapter 1: Responsibilities of a Phlebotomist

- Treat all customers courteously and professionally.
- Ensures all field phlebotomy and specimens are collected accurately and on time.
- Under constant supervision by the Site Lead/Trainer, may practice specimen collection according to established procedures and legal requirements.
- Responsible for completing requisitions accurately
- If applicable, call clients to confirm handwritten orders and verify tests. ordered, obtain accurate billing information (i.e., Diagnosis codes, UPIN information, etc.)
- Research test/client information utilizing the lab computer system or directory of services.
- Label, centrifuge, split, and freeze specimens as required by the test order.
- Package specimens for transport.
- Maintains required records and documentation.
- Reads, understands, and complies with departmental policies, protocols, and procedures: (i.e., Procedure Manuals, Safety Manual, Compliance Manual, Automobile policies and procedures, Employee Handbook, Quality Assurance Manual).
- Maintains all appropriate Phlebotomy logs.
- If applicable, assists with the compilation of monthly statistics and data. Submits data on time.
- Perform basic clerical duties as required, i.e., filing, faxing, and preparing mail.
- Submits accurate time and travel logs as directed by management and on time.
- Submits accurate expense forms, if applicable, on the required day.
- Adheres to departmental and company code of grooming, dress code, and PPE guidelines, and appears professional, neat, and clean at all times.
- Reports on time to work, following attendance guidelines.
- Answers the telephone courteously and professionally, by incorporating the company name, self-identification, and a courteous greeting.

- Communicates appropriately with clients, patients, coworkers, and the public.
- Communicates all unresolved problems immediately to the appropriate Manager or Supervisor
- Remains professional, polite, and courteous at all times.
- Keeps work area neat and clean.
- Disposes of biohazard containers when scheduled.
- Help with inventories and other tasks as assigned.
- Stock supplies as needed.
- Performs other department-related duties when assigned.
- Participates in teams and special projects when asked.
- All other duties as assigned, within the scope of the position.

Phlebotomists play a critical role in the healthcare system by performing various tasks related to blood collection and specimen handling. Their duties encompass a range of responsibilities aimed at ensuring the accuracy, safety, and comfort of patients during the blood collection process. Here are the duties of a phlebotomist:

Additional Duties of a Phlebotomist

Patient Interaction

- Greet and communicate with patients professionally and courteously.
- Provide instructions to patients regarding the blood collection process and any necessary preparations, such as fasting or medication restrictions.

Venipuncture

- Perform venipuncture to collect blood samples from patients using sterile techniques and appropriate equipment.
- Identify suitable venipuncture sites based on patient age, condition, and vein accessibility.
- Ensure patient comfort and safety during the venipuncture procedure.

Capillary Puncture

- Conduct capillary puncture (fingerstick) procedures for blood collection, particularly in pediatric and geriatric patients or when venipuncture is not feasible.

Specimen Collection

- Collect blood specimens in appropriate collection tubes or containers, ensuring proper labeling and documentation.
- Verify patient information and specimen labels to prevent errors in specimen identification.

Specimen Handling and Processing

- Label, handle, and transport collected specimens according to established protocols and safety standards.
- Prepare specimens for laboratory testing, including centrifugation, separation of serum or plasma, and aliquoting as needed.

Infection Control

- Adhere to infection control guidelines and procedures to prevent the transmission of infectious diseases.
- Maintain a clean and hygienic work environment, including proper disinfection of equipment and surfaces.

Quality Assurance

- Ensure the accuracy and integrity of blood samples by following quality assurance measures.
- Monitor and maintain equipment calibration and perform quality control checks as required.

Patient Education

- Provide information to patients about the purpose of blood tests, expected results, and any post-collection instructions.
- Address patient questions or concerns related to blood collection procedures.

Recordkeeping and Documentation

- Document patient information, specimen collection details, and test requisition data accurately and legibly.
- Maintain patient confidentiality and adhere to privacy regulations when handling patient records.

Communication with the Healthcare Team

- Collaborate with other healthcare professionals, including nurses, physicians, and laboratory staff, to ensure coordinated patient care and specimen processing.
- Communicate any issues or concerns related to specimen collection or patient care promptly and effectively.

Continuing Education

- Stay updated on phlebotomy techniques, safety protocols, and industry developments through continuing education and training programs.
- Maintain certification and licensure requirements as applicable in the phlebotomy field.

Physical and mental challenges of a phlebotomist

Phlebotomists may encounter various physical challenges while performing their duties. These challenges can arise from the nature of the work, the environment, or the physical condition of the patients. Here are some common physical problems phlebotomists may face:

1. Musculoskeletal Strain

- Repetitive Motion Injuries: Frequent use of the same muscles and joints for drawing blood can lead to repetitive strain injuries, such as carpal tunnel syndrome or tendonitis.
- Poor Ergonomics: Bending, twisting, or maintaining awkward positions while drawing blood can cause back neck, and shoulder pain.

2. Needlestick Injuries

- Accidental Punctures: Despite strict safety protocols, accidental needlestick injuries can occur, posing a risk of infection from bloodborne pathogens like HIV, hepatitis B, and hepatitis C.

3. Exposure to Infectious Diseases

- Bloodborne Pathogens: Handling blood samples increases the risk of exposure to infectious diseases.
- Respiratory Infections: Working near patients, especially in hospitals or clinics, can expose phlebotomists to respiratory infections like influenza or COVID-19.

4. Allergic Reactions

- Latex Allergy: Some phlebotomists may develop an allergy to latex gloves, leading to skin irritation or more severe allergic reactions.
- Chemical Sensitivities: Exposure to antiseptics, disinfectants, or other chemicals used in the workplace can cause skin or respiratory issues.

5. Stress and Fatigue

- Physical Fatigue: Long hours on their feet, especially in busy healthcare settings, can lead to physical exhaustion.
- Mental Stress: Dealing with anxious or difficult patients, high workload, and the need for precision can contribute to mental and emotional stress.

6. Patient-Related Challenges

- Difficult Veins: Patients with small, fragile, or hard-to-find veins can make blood draws more challenging and physically taxing.
- Uncooperative Patients: Patients who are anxious, uncooperative, or have movement disorders can make the procedure more difficult and increase the risk of injury to both the patient and the phlebotomist.

7. Environmental Hazards

- Slips, Trips, and Falls: Wet or cluttered floors in healthcare settings can pose a risk of falls.
- Exposure to Hazardous Materials: Improper handling or disposal of biohazardous materials can lead to exposure risks.

8. Eye Strain

- Detailed Work: Focusing on small veins and precise needle placement for extended periods can cause eye strain and fatigue.

9. Noise-Induced Hearing Loss

- Loud Environments: Working in noisy environments, such as emergency rooms or busy labs, can contribute to hearing problems over time.

10. Skin Conditions

- Contact Dermatitis: Frequent hand washing and use of gloves can lead to skin dryness, cracking, or dermatitis.

Preventive Measures

To mitigate these physical problems, phlebotomists can take several preventive measures:

- Ergonomic Practices: Use proper body mechanics and ergonomic equipment to reduce strain.
- Personal Protective Equipment (PPE): Wear appropriate PPE, including gloves, masks, and eye protection, to minimize exposure to infectious agents and chemicals.
- Regular Breaks: Take regular breaks to rest and stretch, especially during long shifts.
- Training and Education: Stay updated on best practices for infection control, safe needle handling, and ergonomic techniques.
- Health Monitoring: Regularly monitor and address any signs of physical strain or stress, and seek medical advice when necessary.

By being aware of these potential physical challenges and taking proactive steps to address them, phlebotomists can maintain their health and well-being while performing their essential duties.

Chapter 2: Patient Consent

Patient Consent is the voluntary agreement of an informed individual to undergo a specific medical intervention or procedure, such as venipuncture.

Important Reasons for Obtaining Patient Consent

Respect for Autonomy

- Obtaining informed consent respects the principle of autonomy, acknowledging the patient's right to make decisions about their own body and healthcare.
- This empowers patients to actively participate in the decision-making process related to their treatment.

Informed Decision-Making

- Consent ensures that patients are adequately informed about the procedure, including its purpose, potential risks, benefits, and alternatives.
- This information allows patients to make informed decisions based on a clear understanding of what to expect during and after the venipuncture.

Enhanced Trust and Communication

- Seeking patient consent fosters trust between healthcare providers and patients.
- It promotes open communication, allowing patients to express any concerns, ask questions, and actively engage in their care.
- Trust is a fundamental element in the patient-provider relationship.

Legal and Ethical Requirements

- In many healthcare jurisdictions, obtaining patient consent is a legal and ethical requirement.
- Failure to obtain proper consent can result in legal consequences and damage the patient-provider relationship.
- Adhering to these standards reinforces the principles of medical ethics.

Protection Against Coercion and Pressure

- Patient consent ensures that the decision to undergo venipuncture is voluntary and free from coercion or undue pressure.
- It safeguards against situations where patients may feel compelled to agree to the procedure without fully understanding its implications.

Communication of Privacy and Dignity

- Consent reinforces the importance of respecting the patient's privacy and dignity during the venipuncture procedure.
- Patients have the right to know who will be performing the procedure and the steps that will be taken to maintain their comfort and confidentiality.

Patient-Centered Care

- Incorporating patient consent into the venipuncture process aligns with the principles of patient-centered care.
- It recognizes that patients are individuals with unique values, preferences, and priorities, and their active involvement in decision-making is crucial to achieving positive health outcomes.

Mitigation of Anxiety and Fear

- Venipuncture can be anxiety-inducing for some patients.
- Discussing the procedure and obtaining consent allows healthcare providers to address any fears or concerns the patient may have, contributing to a more positive and cooperative experience.

Documentation of Consent

- Obtaining written or verbal consent provides documentation that the patient agreed to the venipuncture procedure.
- This documentation serves as evidence that the healthcare provider adhered to ethical and legal standards, offering protection in case of any disputes.

Educational Opportunity

- The consent process serves as an educational opportunity for patients to learn more about their health and the importance of specific tests.
- It encourages a collaborative approach where patients and healthcare providers work together for optimal health outcomes.

Obtaining patient consent during venipuncture is vital for respecting autonomy, promoting informed decision-making, building trust, meeting legal and ethical

obligations, and ensuring patient-centered care. It is an integral component of ethical medical practice that contributes to positive patient experiences and outcomes.

Explaining the Procedure to the Patient

Explaining the procedure before drawing blood is crucial for several reasons, all of which contribute to ensuring patient comfort, informed consent, and overall satisfaction with the healthcare experience

Patient Understanding and Informed Consent

- Explaining the procedure provides patients with information about what to expect during the blood draw, including the steps involved, any sensations they may experience, and the purpose of the procedure.
- This empowers patients to make informed decisions and allows them to ask questions or express concerns before the procedure begins.

Reducing Anxiety and Fear

- Many patients experience anxiety or fear when undergoing medical procedures, including blood draws. Providing a clear explanation of the procedure helps alleviate anxiety by demystifying the process and reassuring patients about what will happen. This can lead to increased patient comfort and cooperation during the blood draw.

Building Trust and Rapport

- Transparent communication builds trust between healthcare providers and patients. When patients feel that their healthcare provider is open and honest about the procedure, they are more likely to trust their provider's recommendations and feel confident in the care they receive. This helps strengthen the patient-provider relationship and improves overall patient satisfaction.

Enhancing Patient Cooperation and Compliance

- Patients who understand the rationale behind a medical procedure are more likely to cooperate and comply with the instructions provided by their healthcare provider. By explaining the procedure beforehand, healthcare

providers can encourage patient cooperation and ensure that the blood draw is conducted smoothly and efficiently.

Empowering Patients

- Explaining the procedure empowers patients to take an active role in their healthcare. When patients understand why a blood draw is necessary and how it fits into their overall treatment plan, they are more likely to feel engaged and invested in their health. This can lead to better adherence to treatment recommendations and improved health outcomes.

Addressing Patient Concerns

- Patients may have specific concerns or fears related to the blood draw procedure, such as pain, discomfort, or the possibility of complications.
- By explaining the procedure in advance, healthcare providers can identify and address these concerns, providing reassurance and personalized support to each patient.

Respecting Patient Dignity and Autonomy

- Providing information about the procedure respects the patient's dignity and autonomy by involving them in the decision-making process and allowing them to participate actively in their care. This promotes a patient-centered approach to healthcare that prioritizes the individual needs and preferences of each patient.

Chapter 3: Legal and Ethical Obligations of Patient Identification

Healthcare providers have legal and ethical obligations to protect patients' safety and privacy. Proper identification is a fundamental aspect of meeting these obligations and maintaining the trust of patients.

Proper Patient Identification

Proper *patient identification* before drawing blood is paramount for patient safety, accurate test results, legal and ethical compliance, and the overall efficiency of healthcare delivery. It is a fundamental practice that aligns with the principles of patient-centered care and contributes to positive health outcomes. Health systems and providers should implement robust identification protocols and continuously emphasize the importance of accurate patient identification in clinical practice.

Patient-Centered Care

- Respecting the individuality of each patient is a core principle of patient-centered care. Proper identification acknowledges and honors the patient's identity, fostering a positive and respectful healthcare experience.

Prevention of Identity Theft and Fraud

- Verifying patient identity helps safeguard against identity theft and fraud within the healthcare system. This is especially crucial in an era where personal health information is valuable and subject to misuse.

Avoidance of Medication Errors

- Accurate patient identification is vital in preventing medication errors. Administering medications based on incorrect patient information can lead to adverse drug reactions and other serious consequences.

Efficient Workflow

- Ensures the efficiency of healthcare processes by minimizing errors and avoiding the need for corrective actions. Correct patient identification

streamlines workflow, allowing healthcare providers to focus on delivering timely and effective care.

Confidence in Decision-Making

- Healthcare providers rely on accurate patient information to make informed decisions about diagnosis, treatment, and care plans.
- Proper identification contributes to the confidence and reliability of these decisions.

Enhanced Communication

- Accurate patient identification supports effective communication among healthcare team members. When everyone is certain about the patient's identity, there is less risk of misunderstandings or confusion in the coordination of care.

Reduction of Healthcare Costs

- Proper patient identification helps avoid costly errors, readmissions, or legal consequences associated with misidentification. This contributes to overall cost reduction in healthcare delivery.

Quality Improvement Initiatives

- Accurate patient identification is a foundational element for quality improvement initiatives in healthcare. It supports data accuracy, allowing healthcare organizations to analyze outcomes, identify areas for improvement, and implement evidence-based practices.

Chapter 4: Infection Control

Chain of Infection

The Chain of Infection is a model used to understand how an infectious disease is transmitted from one host to another. This model helps identify different ways to break the chain and stop the spread of infections.

If an individual has recovered from and developed antibodies against a certain virus, it is called "*acquired immunity*" by Johns Hopkins, this type of immunity is a possible response to infection or disease. **[1]**

Most of us are born with an *innate immune* system. It's inherited and made from skin, mucous membranes, and other tissues, all to protect us against germs, parasites, and even cells.

Our acquired immune system gets assistance from our innate system and makes antibodies that protect the body from invaders.

The chain consists of six links:

1. Infectious Agent

- Definition: The pathogen that causes the disease. This can be a virus, bacterium, fungus, or parasite.
- Control Measures: Use of proper sterilization techniques, antibiotics, antivirals, antifungals, or anti-parasitic to eliminate or reduce the infectious agent.

2. Reservoir

- Definition: The natural habitat of the infectious agent where it lives, grows, and multiplies. Reservoirs can include humans, animals, insects, soils, or organic matter.
- Control Measures: Isolation of infected individuals, vector control (e.g., controlling mosquito populations to prevent malaria), and proper sanitation and hygiene to eliminate or control reservoirs.

3. Portal of Exit

- Definition: The path by which the infectious agent leaves the reservoir. This could be through bodily fluids, secretions, excretions, or skin lesions.
- Control Measures: Use of protective barriers (e.g., masks, gloves), covering wounds, and safe handling/disposal of waste and secretions.

4. Mode of Transmission

- Definition: How the infectious agent is spread from the reservoir to a new host. Modes of transmission can be direct (e.g., touching, biting, kissing) or indirect (e.g., airborne, vehicle-borne, vector-borne).
- Control Measures: Hand hygiene, use of personal protective equipment (PPE), proper food handling, air filtration systems, and vector control.

5. Portal of Entry

- Definition: The path through which the infectious agent enters a new host. This can be like the portal of exit and includes the respiratory tract, mucous membranes, skin, and gastrointestinal tract.
- Control Measures: Protective barriers (e.g., masks, condoms), skin wound care, and safe food and water practices.

6. Susceptible Host

- Definition: An individual who is at risk of infection due to a lack of immunity or reduced resistance. Factors that can affect susceptibility include age, health status, immune status, and genetic factors.
- Control Measures: Immunization, health promotion, proper nutrition, and treatment of underlying diseases to boost immunity and reduce susceptibility.

Breaking the Chain

Interventions aimed at breaking the Chain of Infection focus on one or more of these links.

By disrupting the chain at any point, the spread of infections can be stopped or prevented. This is crucial in healthcare settings, community health, and during outbreaks of infectious diseases.

Understanding and implementing control measures at each link of the chain is fundamental in infection prevention and control strategies.

According to the CDC, hospitals (and the vast continuum of healthcare settings) follow CDC recommendations for infection control. **[2]**

According to the National Library of Medicine, "Infection control refers to the policy and procedures implemented to control and minimize the dissemination of infections in hospitals and other healthcare settings with the main purpose of reducing infection rates." **[3]**

Chapter 5: Immunization Requirements for the Health Care Worker:

Immunization is a critical aspect of infection control, especially in healthcare settings where workers are at an increased risk of exposure to infectious diseases and can also potentially transmit these diseases to vulnerable patients.

As a result, healthcare workers (HCWs) are strongly recommended, and in some cases required, to receive certain vaccinations.

While specific immunization requirements can vary by region, employer, and job role, the following are commonly recommended or required immunizations for healthcare workers: [8]

1. 1. Influenza (Flu) Vaccine
    a. *Purpose*: To reduce the risk of flu transmission in healthcare settings
    b. *Frequency*: Annually, as the flu strains covered by the vaccine may change each year.
2. 2. Hepatitis B Vaccine
    a. *Purpose:* To prevent HBV infection, which can be transmitted through exposure to blood or body fluids.
    b. *Dose Schedule*: Usually a series of three doses.
3. 3. Measles, Mumps, and Rubella (MMR) Vaccine
    a. *Purpose*: To protect against measles, mumps, and rubella, highly contagious diseases that can have serious complications.
    b. *Dose Schedule*: Usually, two doses or proof of immunity is required.
4. 4. Varicella (Chickenpox) Vaccine
    a. *Purpose*: To prevent varicella infection, as HCWs can be exposed to or transmit this highly contagious virus.
    b. *Dose Schedule*: Two doses or proof of immunity for those who have not had chickenpox or previous vaccination.
5. 5. Tetanus, Diphtheria, and Pertussis (Tdap) Vaccine
    a. *Purpose*: To protect against these three diseases, with a particular emphasis on pertussis (whooping cough), which can be severe or fatal for infants.

b. *Dose Schedule*: A single dose of Tdap, followed by a Td (tetanus and diphtheria) booster every 10 years.

6. 6. Meningococcal Vaccine
    a. *Purpose*: Recommended for microbiologists or other HCWs who are routinely exposed to isolates of Neisseria meningitidis.
    b. *Dose Schedule*: Depends on the type of meningococcal vaccine used.

Additional Vaccine Considerations

Tuberculosis Screening: Regular TB testing (e.g., skin test or blood test) is recommended for HCWs.

COVID-19 Vaccine: Given the recent pandemic, COVID-19 vaccination is strongly recommended or mandated in many healthcare settings.

Regulatory and Accreditation Requirements Local, Regulations: Immunization requirements can vary by country, state, or local regulations.

Institutional Policies: Individual healthcare institutions may have their own immunization policies, which can be more stringent than national or local guidelines.

Accreditation Bodies: Accrediting organizations for healthcare institutions, such as The Joint Commission, may have standards related to staff immunization.

Communicable Diseases: Communicable diseases, also known as infectious or transmissible diseases, are illnesses caused by pathogens such as bacteria, viruses, fungi, or parasites.

These diseases can be spread, directly or indirectly, from one person to another.

Understanding communicable diseases is crucial in implementing effective control and prevention measures.

Modes of Transmission

Direct Contact: Occurs through physical contact like touching, biting, kissing, or sexual intercourse. Diseases spread this way include HIV/AIDS, herpes, and hepatitis B.

Indirect Contact: Involves contact with a contaminated surface or object (fomite), like doorknobs, utensils, or bedding. Examples include the common cold and influenza.

Droplet Transmission: This involves large droplets that are expelled by coughing, sneezing, or talking and can transmit infections over short distances. Diseases spread this way include the flu, common cold, and COVID-19.

Airborne Transmission: This occurs through smaller droplets or particles that can remain suspended in the air for long periods and can be transmitted over longer distances.

Tuberculosis, chickenpox, and measles are examples of diseases spread this way.

Vector-Borne Transmission: Occurs through vectors such as mosquitoes, ticks, and fleas. Examples include malaria (mosquito-borne), Lyme disease (tick-borne), and plague (flea-borne).

Parenteral Transmission involves direct penetration of the skin through needles, cuts, or bites-route other than through digestion

Common Vehicle Transmission: Involves contaminated substances like food, water, medications, or devices. Diseases spread this way include foodborne illnesses like salmonella and cholera.

Transmission Prevention and Control

- Vaccination: One of the most effective methods to prevent communicable diseases. Vaccines stimulate the body's immune system to protect against specific infections.
- Hygiene and Sanitation: Regular handwashing, safe food handling practices, and proper waste disposal help prevent disease transmission.
- Infection Control Measures in Healthcare Settings: Use of personal protective equipment (PPE), sterilization of instruments, and isolation of infected individuals.
- Public Health Measures: Surveillance, reporting, and tracking of communicable diseases to implement timely interventions and prevent outbreaks.
- Education and Awareness: Informing the public about the modes of transmission and preventive measures for communicable diseases.

Diagnosis and Treatment

- Diagnosis: Involves identifying the causative agent through methods like laboratory tests, imaging, and clinical assessments.
- Treatment: Depends on the type of pathogen and can include antibiotics (for bacterial infections), antivirals (for viral infections), antifungals (for fungal infections), or antiparasitic (for parasitic infections).

Supportive care and symptom management are also important.

Common Communicable Diseases

- Respiratory Infections: Such as influenza, tuberculosis, and COVID-19.
- Gastrointestinal Infections: Like norovirus, salmonella, and E. coli infections.
- Sexually Transmitted Infections (STIs): Including HIV/AIDS, syphilis, and gonorrhea.
- Vector-borne Diseases: Such as malaria, dengue fever, and Lyme disease.
- Zoonotic Diseases: Illnesses that are transmitted from animals to humans, like rabies and bird flu.

Common Pathogens Associated with Antibiotic Resistance Encountered in Health Care Facilities [6]

Antibiotic resistance is a growing global health concern, particularly in healthcare facilities where resistant bacteria can lead to severe infections and limit treatment options. **[6]**

Certain pathogens are notorious for their ability to develop and spread antibiotic resistance. **[6]**

The *Centers for Disease Control and Prevention (CDC)* and the *World Health Organization (WHO)* have classified some of these as urgent or serious threats.

Common antibiotic-resistant pathogens encountered in healthcare settings

Methicillin-Resistant Staphylococcus aureus (MRSA) Resistance

- *Characteristics*: Resistant to methicillin and other beta-lactam antibiotics.
- *Infections Caused*: Skin infections, pneumonia, bloodstream infections, and surgical site infections.
- *Control Measures*: Hand hygiene, contact precautions, screening, and decolonization strategies in certain settings.

Vancomycin-resistant Enterococcus (VRE) Resistance

- *Characteristics*: Resistant to vancomycin and often to other standard treatments.
- *Infections Caused*: Urinary tract infections, bloodstream infections, and wound infections.
- *Control Measures*: Hand hygiene, contact precautions, and prudent use of antibiotics.

Carbapenem-Resistant Enterobacteriaceae (CRE) Resistance

- *Characteristics*: Resistant to carbapenems, a class of antibiotics often considered the last line of defense against resistant bacteria.
- *Infections Caused*: Urinary tract infections, bloodstream infections, ventilator-associated pneumonia.
- *Control Measures*: Hand hygiene, contact precautions, and rapid identification and isolation of infected patients.

Multidrug-Resistant Pseudomonas aeruginosa Resistance

- *Characteristics*: Resistant to multiple classes of antibiotics.
- *Infections Caused*: Pneumonia, bloodstream infections, and infections in burn patients.
- *Control Measures*: Hand hygiene, contact precautions, and proper cleaning of equipment and environment.

Extended-Spectrum Beta-Lactamase (ESBL)-Producing Enterobacteriaceae Resistance

- *Characteristics:* Produce enzymes (ESBLs) that confer resistance to many beta-lactam antibiotics, including penicillin and cephalosporins.
- *Infections Caused*: Urinary tract infections, bloodstream infections, and abdominal infections.
- *Control Measures*: Hand hygiene, contact precautions, and prudent antibiotic use.

Chloridoids difficile (C. difficile) Resistance

- *Characteristics*: Not typically resistant to antibiotics but causes severe, hard-to-treat infections, often due to antibiotic use.
- *Infections Caused*: Diarrhea, colitis.
- *Control Measures*: Hand hygiene (with soap and water, as alcohol-based hand rubs may not be effective against spores), contact precautions, environmental cleaning, and prudent use of antibiotics.

Disease and Pathogen Prevention and Control Strategies

1. *Antimicrobial Stewardship*: Promoting the appropriate use of antibiotics to avoid unnecessary prescriptions and selecting the most appropriate antibiotic, dose, and duration.
2. *Infection Control Practices*: Rigorous hygiene practices, use of personal protective equipment, and isolation of infected patients.
3. *Surveillance and Reporting*: Monitoring and reporting antibiotic-resistant infections to identify outbreaks quickly and implement control measures.
4. *Education*: Training healthcare workers and educating patients about the importance of infection prevention and antibiotic stewardship.

Addressing antibiotic resistance requires a multifaceted approach involving prudent antibiotic use, stringent infection control measures, ongoing surveillance, and continuous education for healthcare professionals and the public. **[6]**

Transmission Precautions **[4]**

Transmission precautions are infection control measures taken in healthcare settings to prevent the spread of infectious agents. **[4]**

These precautions are additional practices that go beyond standard precautions and are used when patients are known or suspected to be infected with pathogens that can be transmitted by airborne, droplet, or contact routes, (EG: precautions or immunocompromised patients.)

The 3 key types of transmission precautions: [4]

Contact Precautions

- *Purpose*: To prevent the spread of infectious agents that are transmitted by direct contact with the patient or by indirect contact with surfaces or objects in the patient's environment. Requires standard precautions and PPE
- *Examples of Pathogens*: Methicillin-resistant Staphylococcus aureus (MRSA), Vancomycin-resistant Enterococcus (VRE), and certain gastrointestinal infections like Clostridioides difficile (C-Diff), also includes Respiratory syncytial virus (RSV) and Covid-19.
- *Key Measures*: Wear gloves and a gown when entering the patient's room. Limited patient movement within the facility ensures that patient-care items, bedside equipment, and frequently touched surfaces are cleaned and disinfected regularly.

Droplet Precautions

- *Purpose*: To prevent the spread of pathogens that are transmitted by large respiratory droplets that can be generated by the patient during coughing, sneezing, or talking
- *Examples of Pathogens*: Influenza, adenovirus, and Neisseria meningitidis.
- *Key Measures*: Wear a mask when working within 6 feet of the patient. Patients' placement in a private room, if available.
- If a private room isn't available, keep the patient's bed at least 3 feet from other patients. Limit the patient's movement within the facility.

Airborne Precautions

- *Purpose*: To prevent the spread of infectious agents that remain suspended in the air.
- *Examples of Pathogens*: Mycobacterium tuberculosis, varicella (chickenpox) virus, and measles virus.
- *Key Measures*: Place the patient in an airborne infection isolation room (AIIR). These rooms have negative pressure relative to the surrounding areas and use high-efficiency particulate air (HEPA) filtration to prevent the spread of pathogens.

Healthcare providers should wear a respirator (e.g., N95 respirator) when entering the room.

Limit patient movement within the facility and ensure that the patient wears a mask when being transported outside the room.

Additional Considerations

Patient Education: Inform patients and their visitors about the precautions being taken, the reasons for those precautions, and how they can help prevent the spread of infection.

Hand Hygiene: Perform hand hygiene before and after all patient contact, contact with potentially infectious material, and before putting on and after removing PPE.

Environmental Cleaning and Disinfection: Ensure that environmental cleaning and disinfection procedures are followed consistently and correctly.

Use of Personal Protective Equipment (PPE): Ensure proper use and disposal of PPE to prevent contamination and the spread of infection.

Transmission precautions are essential in preventing the spread of infectious diseases, especially in healthcare settings. **[4]**

Adhering to these precautions protects not only the patients but also healthcare workers and visitors from potential infections.

Procedures in Isolation Areas

Procedures in isolation areas are designed to prevent the spread of infections when caring for patients with contagious diseases.

These areas are specially designated for healthcare facilities to isolate patients who are infected with or suspected of being infected with communicable diseases.

The procedures not only protect healthcare workers and other patients from acquiring these infections but also ensure the safe and effective management of isolated patients.

General procedures typically followed in isolation areas

Proper Identification and Signage

- *Purpose*: To identify isolation areas and communicate the necessary precautions to all who enter.

- *Procedure:* Place appropriate signage on the doors of the isolation rooms to indicate the type of precautions required (e.g., contact, droplet, airborne).

Use of Personal Protective Equipment (PPE)

- *Purpose*: To protect healthcare workers and visitors from infection.
- *Procedure*: Ensure that PPE is available and used appropriately according to the type of isolation. This may include gloves, gowns, masks, respirators, face shields, or goggles.

Hand Hygiene

- *Purpose*: To prevent the spread of pathogens via hands, which are a common vector.
- *Procedure:* Perform hand hygiene before entering and after leaving the isolation area, before and after removing PPE, and after any contact with the patient or their immediate environment.

Limiting Patient Movement and Transport

- *Purpose*: To minimize the risk of spreading the infection to other areas of the facility.
- *Procedure*: Keep the patient in the isolation area as much as possible. If transport is necessary, use appropriate barriers (e.g., masks for the patient) and inform receiving departments about the precautions needed.

Environmental Cleaning and Disinfection

- *Purpose*: To reduce the risk of environmental contamination.
- *Procedure*: Ensure regular and thorough cleaning and disinfection of the isolation area, especially frequently touched surfaces.

Follow specific protocols for the disposal of contaminated materials. Limit entry to essential personnel only.

Ensure that all who enter are aware of the necessary precautions and know how to use PPE correctly.

Proper Waste Disposal

- *Purpose*: To safely dispose of contaminated materials.
- *Procedure*: Follow protocols for the safe disposal of infectious waste, including sharps, PPE, and other materials used in patient care.

Equipment Management

- *Purpose*: To prevent equipment from becoming a source of transmission.
- *Procedure*: Dedicate medical equipment to the isolated patient, if possible.

If equipment must be shared, clean and disinfect it thoroughly before use on another patient.

Carry only necessary equipment into the isolation area for specific tests, carry extra tubes, and when you leave, dispose of everything you did not use that entered the isolation room.

Reverse Isolation

Reverse isolation, also known as protective isolation or neutropenic precautions, is a set of infection control practices used to protect patients who are highly susceptible to infections due to weakened immune systems.

Unlike *standard isolation*, where the goal is to prevent an infected patient from transmitting infections to others, reverse isolation aims to protect a vulnerable patient from external infections.

This is a common practice used in settings for patients with compromised immune systems, such as those undergoing chemotherapy, newborns, bone marrow transplants, or with certain immune deficiencies.

Reminders for the Patient:

Patients might need to wear PPE when leaving the room for tests or procedures to protect them from exposure to infectious agents.

Hand Hygiene

- Rigorous hand hygiene practices are essential. Healthcare workers, visitors, and even the patients themselves should frequently wash hands or use alcohol-based hand sanitizer.

Visitor Restrictions

- Limiting visitors to reduce the patient's exposure to potential infections. Visitors may be screened for symptoms of illness before entering the room.

Food and Item Safety:

- Dietary restrictions might be in place to avoid foods that are at a higher risk of carrying bacteria (e.g., raw fruits and vegetables, and unpasteurized products).
- Careful cleaning or avoidance of items that are difficult to clean or that commonly harbor bacteria (e.g., flowers or plants).

Staff Education and Monitoring:

- Staff should be well-trained in infection control practices specific to reverse isolation. Regular monitoring to ensure adherence to the protocols.

Chapter 6: Blood-Borne Pathogens (BBP)

Blood-borne pathogens (BBPs) - microorganisms such as viruses or bacteria that are carried in the blood and can cause disease in people.

These pathogens can be transmitted through contact with infected blood and other potentially infectious materials, such as certain body fluids.

The most common and dangerous examples of BBP include *the Human Immunodeficiency Virus (HIV), Hepatitis B Virus (HBV), and Hepatitis C Virus (HCV).*

Understanding BBPs and how they are transmitted is crucial for implementing effective preventive and control measures, especially in healthcare settings.

Modes of Transmission for BBPs

- *Percutaneous Exposure*: Through a needlestick or cut from a sharp object contaminated with infected blood.
- *Mucocutaneous Exposure*: Through contact with mucous membranes (such as the eyes, nose, or mouth) or non-intact skin (such as chapped, abraded, or afflicted with dermatitis) with infected blood.
- *Sexual Contact*: Through sexual practices that involve exposure to blood or other potentially infectious body fluids.
- *Mother-to-Child Transmission*: A pregnant woman can transmit the virus to her baby during childbirth.

Needlestick Safety and Prevention Act

OSHA requires employers to *maintain a sharps injury log to record injuries* from contaminated sharps.

The log must maintain the confidentiality of the injured employee and include details about the incident.

Employers must also provide:

- *Needle safety devices*
- *Sharps disposal systems*
- *Properly label waste containers*
- *Mandatory standard practice precautions*
- *Do not allow food, drinks, or smoking at workstations*
- *Do not allow the application of makeup at workstations*
- *Provide fitting PPE for all employees*
- *Laundry facilities*
- *Free Hep b vaccines*
- *Medical attention for BBP exposure*
- *And documentation of any incidents regarding finger sticks*

Things to remember

1) Report all needle sticks
    - Within 24 hours, antibody titers are measured and PEP (postexposure prophylaxis) should be given and to prevent infection
2) Chemical Hazards
    - Always observe labels and follow instructions when using chemicals in the lab
    - Should you be exposed to needle stick or chemicals, keep exposed area under running water for at least 15-20 mins, and seek medical attention.
3) Biological Waste
    - Bins with biological hazard signs, should always to available for items contaminated with bodily or blood fluids. These are usually color-coded yellow or red.
    - This includes items such as bandages, used gauze, alcohol pads, and PPE. Urine can be disposed of in the sink at the lab.
    - Blood spills must be cleaned with an absorbent material, then disinfected with sodium hypochlorite (1 part with 10 parts water).

Other types of biological waste

- *Sharps* – needles, blades, and broken glass
- *Pathological or Anatomical* items from the human body
- *Infectious items* such as bandages, dressings, and used PPE

- *Recyclable items* – items autoclaved (cleaned with steam under pressure to kill germs), including bottles, catheters, and syringes w/o needles
- *Chemical* – Formaldehyde, or infected secretions
- *Pharmaceutical* – expired or discarded medications

Chapter 7: Personal Protective Equipment (PPE)

Personal Protective Equipment (PPE) refers to protective clothing, helmets, gloves, face shields, goggles, facemasks, and/or respirators or other equipment to protect the wearer from exposure to infectious materials.

PPE acts as a barrier between infectious materials and the skin, mouth, nose, or eyes. Its use is a crucial part of infection control and safety protocols in various settings, especially healthcare.

Common types of PPE:

Gloves

- *Purpose*: To protect hands from contamination with infectious agents and chemicals.
- *Usage:* Gloves should be worn when there is potential for contact with blood, bodily fluids, mucous membranes, non-intact skin, or contaminated equipment.

Gowns or Aprons

- *Purpose*: To protect skin and clothing from contamination.
- *Usage:* Worn during procedures and patient-care activities that are likely to generate splashes or sprays of blood, body fluids, secretions, or excretions.
- It should be the correct size, worn properly, and secured behind the neck and waist.

Masks and Respirators:

- *Purpose*: To protect the mouth and nose from splashes of blood or bodily fluids. They can also reduce the risk of spreading infections, particularly in surgical or other clinical settings or from inhalation of infectious aerosols (e viruses like tuberculosis or COVID-19)
    - Eg: 3 layers mask, Respirators (e.g., N95):

- *Usage:* Should be properly fitted and worn in situations where airborne precautions are necessary.

Goggles or Face Shields:

- *Purpose:* To protect the mucous membranes of the eyes from splashes of blood or bodily fluids.
- *Usage*: Worn during procedures and patient-care activities that are likely to generate splashes or sprays.

Head and Shoe Covers:

- *Purpose:* To protect hair and shoes from contamination, mainly used in operating rooms or in situations where a sterile environment is crucial.
- *Usage*: Worn when there is a possibility of contamination of the environment with pathogens or when entering a controlled environment.

Sequence of Donning

The Centers for Disease Control and Prevention (CDC) provide guidelines on the proper order to don PPE. [5] It's important to perform hand hygiene before putting on PPE.

Students should regularly undergo training and practice the correct way to don PPE to ensure you're protected effectively.

Remember, the correct order of donning PPE is crucial, but equally important is the sequence of doffing (removing) PPE to avoid contamination.

Proper disposal or disinfection of PPE is also essential to maintain safety standards.

Recommended Sequence of Donning:

1) *Gown:* Fully cover the torso from neck to knees, arms to end of wrists, and wrap around the back. Secure/Fasten at the neck and waist.

2) *Mask or Respirator*: Place over nose, mouth, and chin. Fit a flexible nose piece over the nose bridge. Secure on the head with ties or elastic.

Adjust to fit – for N95 respirators, perform a fit check according to the manufacturer's instructions.

- For tying the mask, *tie 1st above and behind the head and then at the neck*,
- For a mask that slips on, *fit over the nose and mouth with one hand while the other hand secures it safely over your head*

Goggles or Face Shield:

- Place over face and eyes. Adjust to fit.

3) *Gloves:* Extend to cover the wrist of the gown. Ensure there is no skin exposed between the glove and the gown.

- *No Gaps*: Ensure there are no gaps in the PPE where infectious material could enter.

Comfort and Correct Fit: Make sure the PPE is comfortable and fits correctly. Discomfort can lead to touching or adjusting the PPE, which can lead to contamination.

Sequence of Doffing (PPE Removal)

The sequence of removing (doffing) personal protective equipment (PPE) is equally as important as donning because improper technique can lead to contamination of the wearer or the environment.

The Centers for Disease Control and Prevention (CDC) provide guidelines on the proper order to remove PPE to minimize the risk of self-contamination. **[5]**

Sequence of Doffing (removal):

1)Gloves (often the most contaminated PPE)

- Grasp the outside of one glove at the wrist without touching your skin. Peel the glove away from your hand, pulling it inside out.
- Hold the glove you just removed in your gloved hand.
- Peel off the second glove by putting your fingers inside the glove at the top of your wrist and turning the second glove inside out while pulling it away from your hand, leaving the first glove inside the second.

- Dispose of the gloves safely. Do not touch your bare hands to the outside of the gloves.

2) *Goggles or Face Shield* - Handle with headband or earpieces.

- Tilt your head forward slightly, and lift the headband or earpieces up and away from your head.
- Avoid touching the front of the goggles or face shield.
- Clean and disinfect reusable eye protection according to the manufacturer's instructions before reuse.

3) *Gown*: You may need assistance from another healthcare worker to unfasten the gown ties if they are in the back.

- Peel the gown away from your neck and shoulder, turning the contaminated side inward and folding or rolling it into a bundle (only touching the inside of the gown).
- Dispose of the gown safely or place it in the designated receptacle for reprocessing if it's reusable.

4) *Mask or Respirator*: Tilt your head forward slightly.

- *For masks*: Untie or break the bottom ties, followed by the top ones, and remove by handling the ties only.
- *For respirators*: Remove the bottom strap by lifting it over your head, then remove the top strap, being careful not to touch the front of the respirator. Dispose of the mask or respirator safely.

5) *Hand Hygiene*

- *Purpose*: To ensure that any contaminants that may have been transferred to your hands are removed.
- *How to Perform*: After removing PPE, immediately wash your hands with soap and water for at least 20 seconds or use an alcohol-based hand sanitizer.
- Hand washing must be effective in preventing contamination.
- Proper procedure, according to the CDC, includes standing back from the sink, lathering 15–20 seconds, and drying hands thoroughly with a clean disposable towel.
- Once hands are thoroughly dried, use a clean, dry, disposable towel to turn the faucet off.

Important Tips Be Methodical: Remove PPE slowly and deliberately in the correct sequence to prevent self-contamination.

Dispose Properly: Dispose of or disinfect PPE appropriately after removal.

Avoid Touching Face: Throughout the process, be careful not to touch your face or adjust other PPE as this can lead to contamination.

Remember, the correct removal of PPE is a critical step in preventing the spread of contamination and ensuring the safety of healthcare workers and others in the environment.

Chapter 8: Immediate First Aid

A phlebotomist should be aware of the various scenarios in which PEP & or immediate first aid should be administered

Scenarios for administering First aid & PEP

How to administer immediate first aid for a needlestick or cut:

1. Wash the area with soap and water.
2. For mucous membrane exposure:
3. Rinse the area with water or saline.
4. Seek Medical Attention Immediately
5. Report the incident to the occupational health department (for occupational exposures) or visit an emergency department or healthcare provider as soon as possible.
6. Assessment and Initiation of PEP (post-exposure prophylaxis): The healthcare provider will assess the risk of exposure and, if PEP is warranted, will prescribe a course of antiretroviral medications.
    A. PEP should be started as soon as possible, ideally within a few hours and no later than 72 hours after the potential exposure.
7. *Duration of Treatment*: PEP involves taking antiretroviral medications for 28 days.
8. *Follow-Up*: Follow-up appointments will include monitoring for drug side effects, testing for HIV and other pathogens (such as HBV or HCV if applicable), and counseling.

Hepatitis B Postexposure Prophylaxis (PEP)

- For exposure to hepatitis B, PEP can involve the administration of hepatitis B immunoglobulin (HBIG) and hepatitis B vaccine, depending on the vaccination and immunity status of the exposed person.

Rabies Postexposure Prophylaxis (PEP)

- PEP for rabies exposure involves wound cleaning and administration of rabies immunoglobulin (RIG), followed by a series of rabies vaccinations.

Importance of PEP Prevention of Infection:

- PEP can significantly reduce the risk of acquiring HIV, hepatitis B, and other infections after potential exposure.
- Time Sensitivity: The effectiveness of PEP diminishes with time; hence, it's crucial to start the treatment as soon as possible after the exposure.
- Comprehensive Care: PEP is not just about medication; it also involves counseling, support, and follow-up care to ensure the best possible outcome.

PEP is a crucial intervention in managing occupational and non-occupational exposures to certain pathogens. However, it is not a substitute for regular preventive measures, such as using protective barriers (e.g., condoms, gloves), safe handling and disposal of sharps, and getting vaccinated where vaccines are available (e.g., HBV, rabies).

Chemical Hazards

Chemical hazards refer to substances that can cause harm or pose a threat to health, safety, or the environment when used or released improperly.

In the workplace, particularly in industries like manufacturing, healthcare, and construction, employees may be exposed to various chemical hazards.

Understanding these hazards, their potential effects, and how to manage them is crucial for maintaining a safe working environment.

Chapter 9: Human Anatomy Overview

Understanding and using these anatomical terms correctly is crucial for clear communication in healthcare, biology, and related fields, especially when describing the location of symptoms, surgical procedures, or the movement of substances within the body.

Anatomical terms

- Help us describe different parts of the body clearly and accurately. They are especially important in biology, medicine, and anatomy. Many of these terms come from Latin or Greek and are used in a standard way to avoid confusion.

Anatomical Terms to know:

- *Bone:* Hard, dense organs that constitute part of the endoskeleton (e.g., femur, humerus).
- *Muscle*: Tissue that produces force and motion to move the body or produces movement in internal organs (e.g., biceps, heart muscle).
- *Tendon*: A flexible but inelastic cord of strong fibrous collagen tissue attaching a muscle to a bone.
- *Ligament*: A short band of tough, flexible, fibrous connective tissue that connects two bones or cartilages or holds together a joint.
- *Organ*: A group of tissues that perform a specific function or group of functions (e.g., heart, liver, kidney).

Tissues

- Tissues are groups of cells that work together to perform specific functions.
- In the human body, there are *four primary types of tissues*, each with unique structures and roles.

4 Types of Tissues:

1. Epithelial Tissue:

a. Epithelial tissue covers the body surfaces, lines the cavities and organs, and forms glands.
b. It serves as a barrier for protection, controls permeability to substances, provides sensation, and produces secretions through glandular structures.
c. Examples:
    i. *Skin*: Protects against environmental damage.
    ii. *The lining of the stomach and intestines*: Absorbs nutrients and secretes digestive enzymes.
    iii. *Glandular epithelium*: Forms glands that produce hormones and other secretions.

2. Connective Tissue:
    a. *Primary Function*: Connective tissue supports, binds together, and protects tissues and organs.
    b. It also stores energy as fat, provides immunity, and transports substances within the body.
    c. Examples:
        i. *Bone*: Provides structural support and protection for organs and produces blood cells.
        ii. *Adipose (fat) tissue*: Stores energy, insulates, and cushions organs.
        iii. *Blood:* Transports oxygen, nutrients, and waste products; involved in immune responses.
        iv. *Cartilage*: Provides flexible support and reduces friction between bony surfaces.
        v. *Tendons and Ligaments*: Connect muscles to bones (tendons) and bones to bones (ligaments), providing stability and facilitating movement.
3. Muscle Tissue:
    a. *Primary Function*: Muscle tissue is responsible for producing movement, maintaining posture, and generating heat through contractions.
    b. *Myalgia* – muscle pain
    c. Examples:
        i. *Skeletal Muscle*: Facilitates voluntary movements by attaching to bones.

ii. *Cardiac Muscle*: Constitutes the heart's wall and pumps blood throughout the body.
iii. *Smooth Muscle*: Found in walls of internal organs (like the intestines, blood vessels, and bladder), controlling involuntary movements like the constriction and relaxation of blood vessels.

4. Nervous Tissue:
    a. *Primary Function*: Nervous tissue receives, transmits, and integrates information from internal and external environments to control the body's functions. It's the main component of the nervous system.
    b. Examples:
        i. *Neurons:* Conduct impulses and are the basic unit of the nervous system.
        ii. *Neuroglia (or Glial Cells):* Support and protect neurons, maintain homeostasis, form myelin, and provide support and protection for neurons.

Each tissue type has a distinct structure and function, and they work together to maintain the body's health, support its structure, and facilitate its movements and functions.

Organs

- A body system is made up of a few organs that perform interrelated functions.
- The organs are even more complex. A few tissue types compose an organ.
- For example- the *heart comprises cardiac muscle tissue covered by an epithelial lining supported by connective tissues.*
    - The *heart and blood vessels make up the circulatory* system.
    - The *urinary system eliminates waste and balances the body's pH*.
    - The *kidneys* filter the blood to remove waste and unnecessary ions concentrated in the urine. The urine passes from the kidneys to the *ureters*. The bladder stores *urine* until it is released through the urethra.

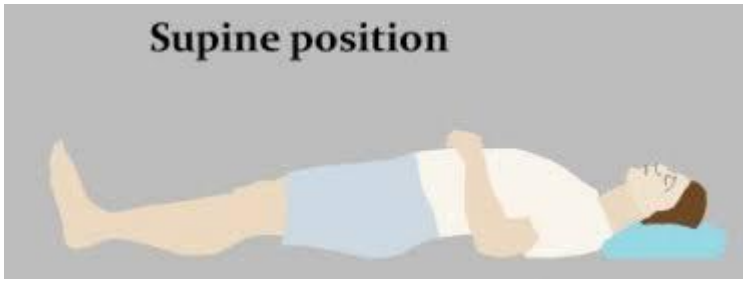
Body Positions

Understanding body positions is crucial in various fields, particularly in healthcare, physical therapy, and fitness. It helps in diagnosing conditions, planning treatments, or executing physical activities correctly.

Common body positions

Anatomical Position: This is the standard reference position for the body in the study of anatomy. The person stands erect, facing forward, with feet slightly apart and parallel, and arms at the sides with palms facing forward.

Supine Position: The person lies on their back with their face upward. This position is often used in surgical procedures and when examining the anterior (front) side of the body.

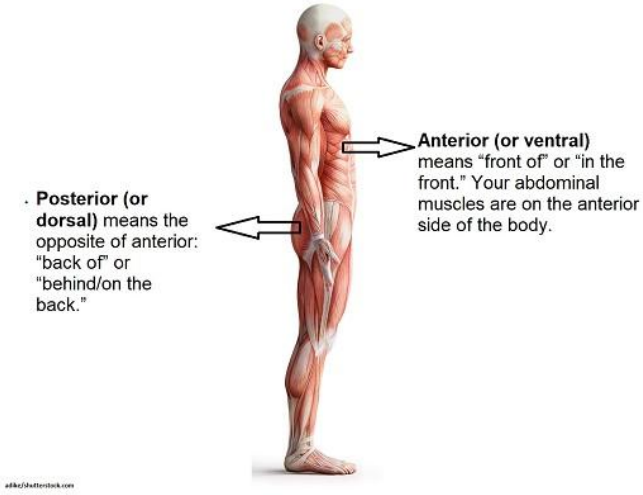


Anatomy Directional Terms

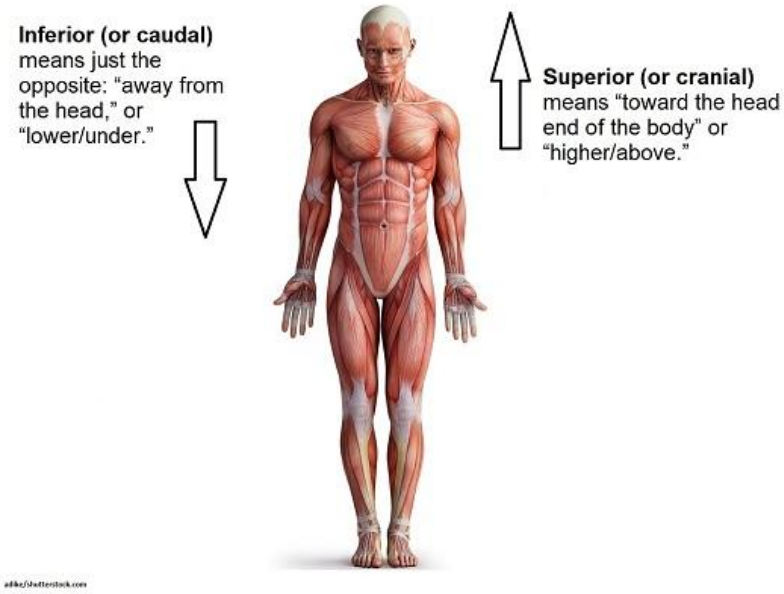
- *Directional terms* are used in anatomy to describe the locations of structures with other structures or locations within the body.
- These terms are essential for clear communication, especially in the fields of medicine, biology, and anatomy.

Important directional terms:

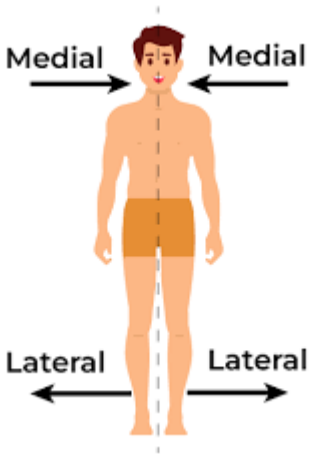
- *Anterior (Ventral):* Toward the front of the body.
- *Posterior (Dorsal):* Toward the back of the body.



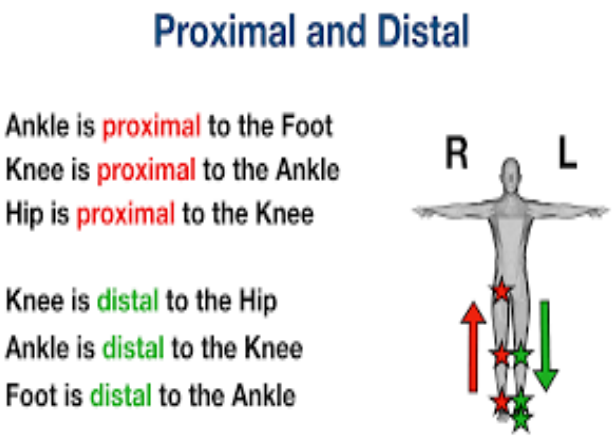
- *Superior (Cranial):* Toward the head or upper part of a structure.
- *Inferior (Caudal):* Away from the head, or toward the lower part of a structure.



- *Medial:* Nearer to the midline of the body.
- *Lateral:* Farther from the midline of the body.



- *Proximal*: Closer to the origin of the body part or the point of attachment of a limb to the body trunk.
- *Distal:* Farther from the origin of a body part or the point of attachment of a limb to the body trunk.



- *Superficial (External)*: Toward or at the body surface. The skin is superficial to the muscles.

Understanding and using these terms accurately can *help in identifying the precise location of structures and describing the position of surgical incisions, injuries, or diseases relative to body landmarks.*

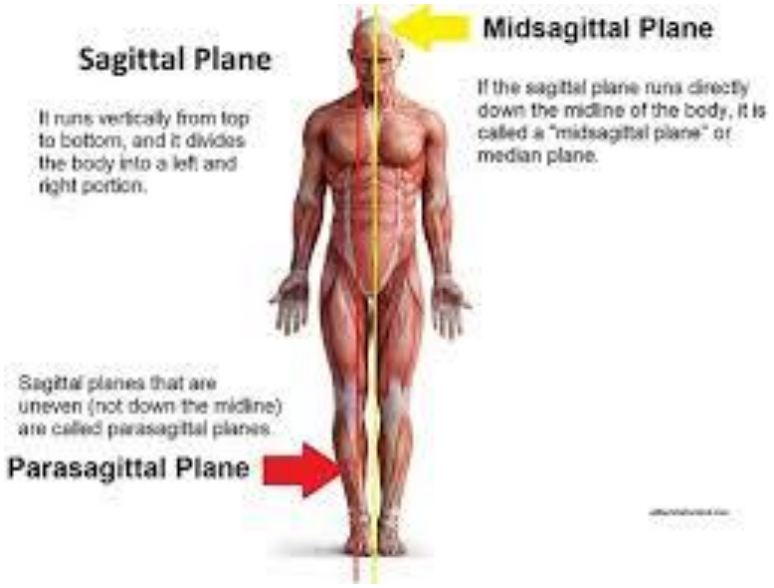
Anatomical Planes

Anatomical planes are *imaginary lines* used to divide the human body into sections. These planes are essential in medical and anatomical terminology for *describing the locations and movements of various parts of the body* with precision.

Main anatomical planes

Sagittal Plane: This vertical plane divides the body into left and right parts.

- When a sagittal plane runs directly *along the midline of the body*, it is referred to as the *midsagittal (or median) plane*, dividing the body into equal right and left halves.
- Planes parallel to the midsagittal plane are called *parasagittal planes*.



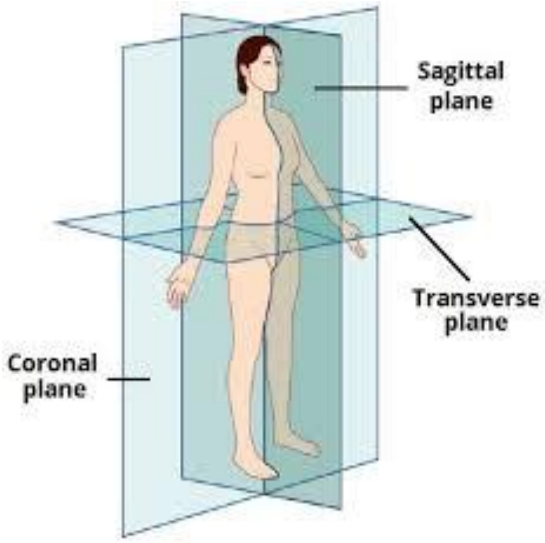
<u>*Frontal (Coronal) Plane*</u>: This is another type of vertical plane, but it divides the body into anterior (front) and posterior (back) sections.

- It runs *perpendicular to the sagittal plane and parallel* to the face, effectively splitting the body into front and back halves.

<u>*Transverse (Horizontal) Plane*</u>: This plane divides the body into *superior (upper) and inferior (lower) parts*. It runs perpendicular to both the sagittal and frontal planes, creating a cross-section that *separates the body into top and bottom halves*.

- This plane is also referred to as the cross-sectional or axial plane, especially in radiological contexts.

<u>*Midsagittal Plane*</u>: Cuts through vertically into equal right and left sections.

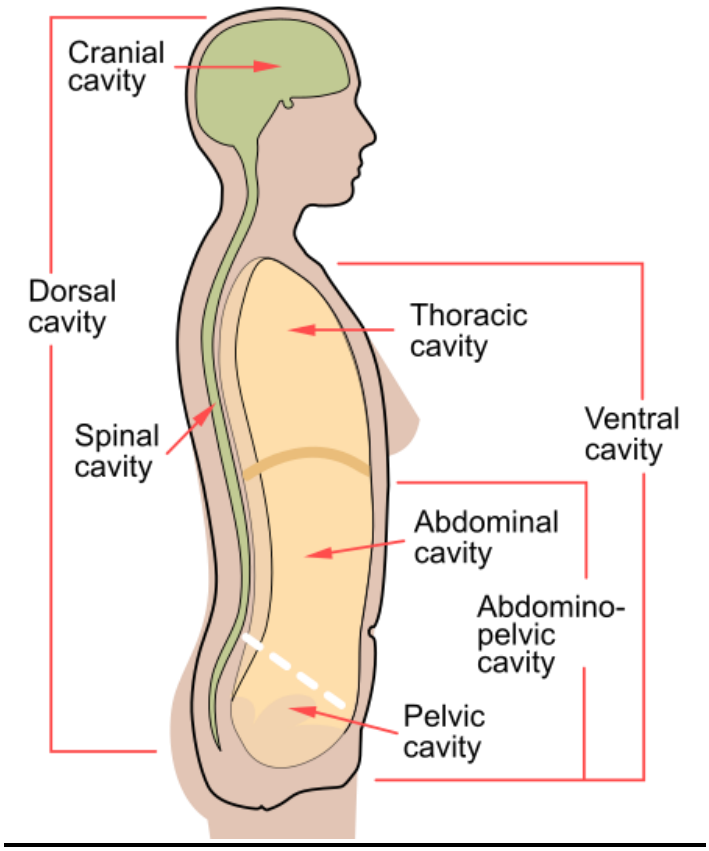


Understanding these planes is crucial for professionals in healthcare and related fields, as they provide a standardized way of describing the location or direction of movements relative to the body.

They are also fundamental in medical imaging techniques such as MRI and CT scans, which provide cross-sectional images along these planes to help diagnose conditions, plan treatments, or guide surgical procedures.

Body Cavities

Body cavities *are enclosed spaces within the body that house and protect vital organs.* In human anatomy, these cavities are distinct and organized, allowing for the separation and support of different organ systems.



- *Dorsal Body Cavity*: This cavity is on the posterior (back) side of the body and is divided into two subdivisions:
- *Ventral Body Cavity*: Located on the anterior (front) aspect of the body, it is larger than the dorsal cavity and is subdivided into two main parts, separated by the *diaphragm muscle*:
- *Cranial Cavity*: Encases the brain.
- *Spinal Cavity:* Encloses the spinal cord.
- *Thoracic Cavity*: Contains the heart and lungs, among other structures.
- *Abdominal Cavity*: Houses many digestive organs, the liver, and other organs.
- *Pelvic Cavity*: Contains the urinary bladder, some reproductive organs, and the rectum.

These cavities are *lined by membranes that not only protect the organs within them but also allow for the organs' movements and expansions*.

For example, the thoracic and abdominopelvic cavities are lined by the serous membrane, which is divided into the *parietal serosa* (lining the cavity walls) and the visceral serosa (covering the organs).

Understanding the organization of body cavities is crucial in anatomy, medicine, and related fields, as it helps in diagnosing diseases, planning medical procedures, and understanding the body's complex structure and functions.

Chapter 10: Human Body Systems

Integumentary System

The integumentary system is a complex set of organs that plays critical roles in protecting the body against:

- external threats,
- regulating body temperature,
- and providing sensory information.

It is comprised of the *skin and its associated structures, including hair, nails, sweat glands, and oil glands.*

Here's a detailed overview of the integumentary system's components and their primary functions:

Layers of the Skin

Epidermis: The outermost layer, providing a waterproof barrier and creating our skin tone.

- It contains several types of cells,
- *Keratinocytes* (producing keratin, a protein that strengthens the skin),
- *Melanocytes* (producing melanin, which gives skin its color),
- *Langerhans' cells* (involved in immune responses), and
- *Merkel cells* (involved in touch sensation).

Dermis: Beneath the epidermis, this layer contains tough *connective tissue, hair follicles, and sweat glands.*

It houses:

- blood vessels,
- lymph vessels,
- nerve fibers, and the bases of
- sweat and oil glands,

- provides skin nutrition, waste removal, temperature regulation, and sensation.

Dermal Papillae

- Connect the dermis to the epidermis. These are uneven projections or ridges. The patterns they produce create unique fingerprints and footprints in every individual.

Apocrine Glands

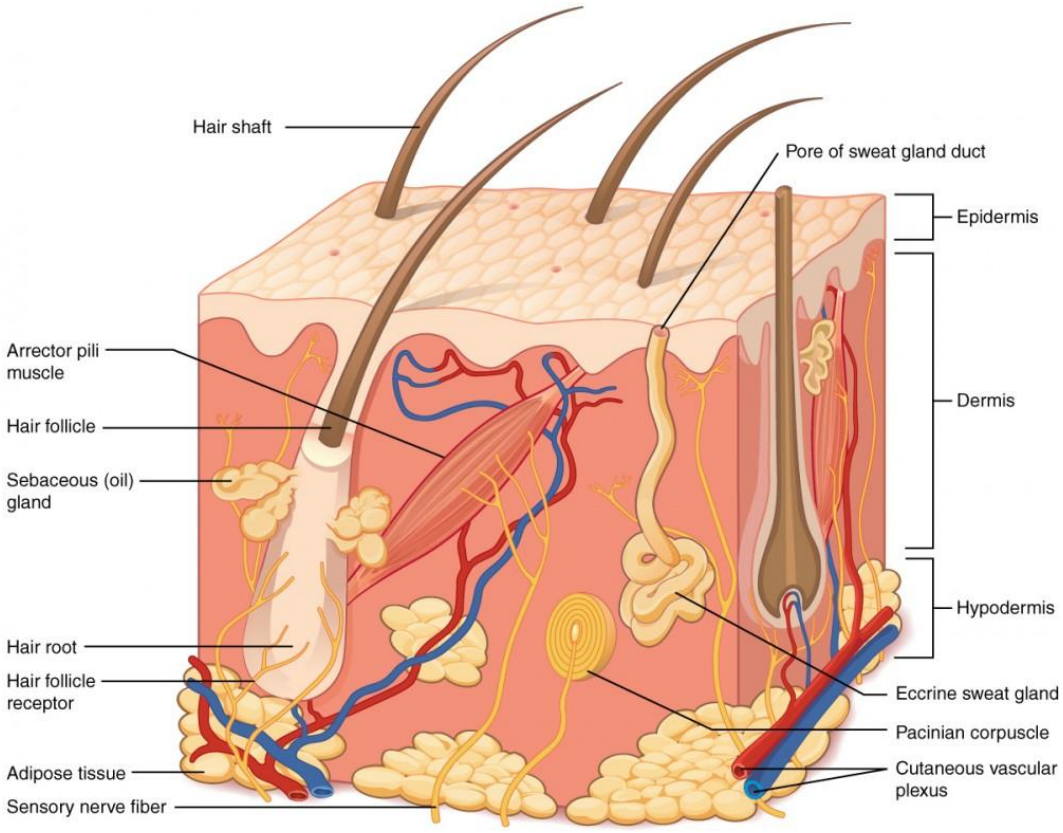
- Located within the dermis and extends up to the epidermis. They regulate body *temperature and eliminate waste from the pores through sweat*.

Sebaceous Glands

- Is a type of oil that keeps hair and skin moisturized.

Subcutaneous Layer

- Is made up of fat connecting the organs to the skin. It functions as a *shock absorber, an energy reserve, and insulation.*



Common Skin Disorders

Common skin disorders vary widely in symptoms and severity. They can be temporary or permanent and may be painless or painful.

Some have situational causes, while others may be genetic. *Phlebotomists must be aware of skin issues to avoid unsuitable venipuncture sites*

Contact Dermatitis - an allergic reaction to irritant substances, like soap, make-up, or plants

Eczema (Atopic Dermatitis): A condition that causes inflamed, itchy, cracked, and rash-type skin sore. It's more common in children but it can occur at any age. Eczema may be chronic and flare up periodically.

- It may also be accompanied by asthma or hay fever.

Impetigo: Is a form of an infection of Staphylococcus or Streptococcus bacteria or both. It presents as a pus-filled lesion that dries to become a yellowish crust.

Keloid: a type of hypertrophic scar resulting from excess collagen produced during skin healing.

Dermatologists - are specialists who can diagnose these conditions and recommend appropriate treatments.

Treatment for skin disorders varies depending on the condition and its severity and can range from topical treatments and medications to lifestyle changes and procedures.

Commonly Ordered Tests for Skin Diseases

Diagnosing skin diseases often requires a combination of clinical evaluation and specific tests. These tests help dermatologists and healthcare providers determine the exact nature of a skin condition and the most effective treatment plan.

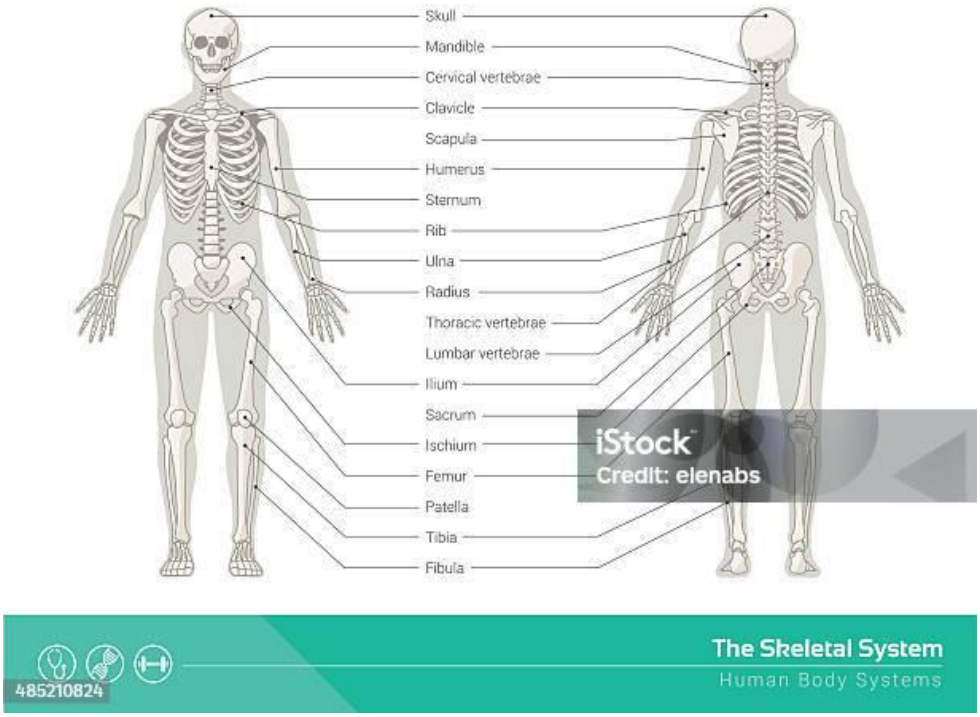
Commonly ordered tests for diagnosing skin diseases

- *Culture and sensitivity test*: Bacterial, fungal, or viral cultures may be taken from wounds, the skin, nails, or hair to identify the cause of an infection.
- This involves growing the organism in a lab to identify it and, often, to test its sensitivity to different antibiotics or antifungals.
- *Special staining*: Identifies pathogens.
- *Microscopy of the skin scrapings*: Fixed in potassium hydroxide to detect fungi.
- *Punch biopsies*: Distinguishes benign tumors from malignant tumors.

Skeletal System

The skeletal system is made up of *bones, joints, and ligaments*, which makes movement possible in conjunction with the muscles and nerves.

The skeletal system *provides support and protection*. It also *stores calcium and phosphorus.*



Common Conditions Affecting the Skeletal System

Osteoporosis: A condition characterized by weakened bones that are more prone to fracture.

- It occurs when the body loses too much bone, makes too little bone, or both, leading to porous and fragile bones.
- Osteoporosis is more common in older adults, especially postmenopausal women, due to lower estrogen levels.

Arthritis: This is a general term for conditions *affecting the joints and surrounding tissues, leading to pain, stiffness, and swelling.*

- The most common types are *osteoarthritis,* which results from *wear and tear of the cartilage in joints*, &
- *rheumatoid arthritis*, an *autoimmune condition* that attacks the lining of the joints

Fractures: Breaks in bones, often caused by trauma, falls, or conditions that weaken the bones, such as osteoporosis. The severity of fractures can vary from minor cracks to complete breaks.

- *Osteomyelitis* Is an *infection of the bone and its deeper layers*, including the marrow. An *improper heel puncture traumatizes the bone and can lead to osteomyelitis.*
- Early diagnosis and treatment are crucial for managing symptoms and preventing further damage.

Commonly Ordered Tests Involving the Skeletal System

- *Synovial fluid*: Normal sterile fluid lubricating the joint spaces, can be aspirated to investigate the presence of bacteria crystals for the diagnosis of joint inflammation or arthritis.
- *Wound culture*: Performed to identify causative agents in suspected osteomyelitis.

Muscular System

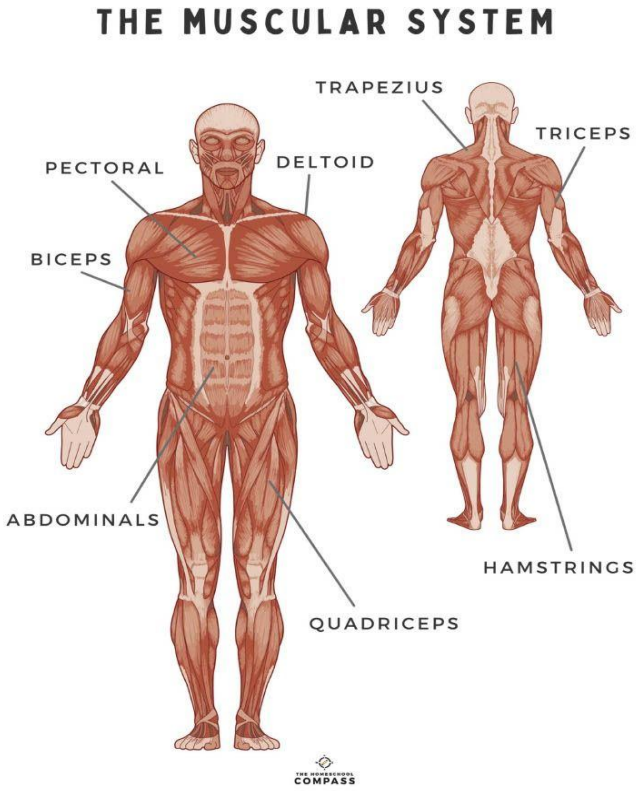
The muscular system is a complex network of *muscles and tissues that are vital for movement, stability, and overall bodily function.*

Skeletal Muscle

- *Functions*: Skeletal muscles are *striated*, attached to the bone, and responsible for voluntary movements, posture, and body support.

Smooth Muscle

- *Function:* Smooth muscle tissues are *found in the walls of internal organs and blood vessels.*
    - They control *involuntary movements such as the contraction and relaxation of blood vessels, movement of food through the digestive tract, and the regulation of airways in the lungs.*
- *Characteristics*: These muscles *are not striated*; they have a smooth appearance and operate *involuntarily*. Smooth muscles are *slower to contract* than skeletal muscles, but they can maintain contractions for a longer time without fatigue.



Common Conditions Affecting the Muscular System

The muscular system is crucial for movement, stability, and overall body function. However, it can be affected by a range of conditions that impair its performance, leading to discomfort, reduced mobility, or more serious health issues.

- *Atrophy*: The loss of muscle bulk from inactivity.
- *Myalgia:* A general medical term to refer to any caused by viral infections or accidents.
- *Poliomyelitis*: Results from a viral infection affecting the nerves that supply the muscles. It results in a progressive loss of strength and paralysis. Vaccines are available which confer lifelong immunity from the condition.

The Nervous System

The nervous *regulates and coordinates* body activities. It is divided into two main parts: the *central nervous system (CNS)* and the *peripheral nervous system (PNS).*

The Nervous system is composed of:

- *Neuron* – a cell body surrounded by dendrites and a single tail or axon
- *Dendrites* – receives information through electrical impulses, and then information is sent out through the *axon*.
- *Myelin sheath* – (produced by Schwann cells), wraps around the axon and dendrites to send information from electrical impulses more effectively.
- *Synapse* – where impulses in nerve cells are transmitted from axon to other
- Dendrites

<u>Central Nervous System (CNS)</u>

The CNS includes the *<u>brain and spinal cord</u>*. It is the *control center for the entire body, responsible for processing and sending signals and interpreting incoming sensory information.*

<u>Brain</u>:

- The brain is the body's *control center*. It's responsible for *processing sensory information, regulating blood pressure and breathing, and releasing hormones.*
- The brain is divided into several parts, including the *cerebrum, cerebellum, and brainstem, each with specific functions.*

The CNS is *encased in meningeal layers (shock absorbers) under the skull and vertebrae.*

Sensory (afferent) neurons receive information from sensory organs and relay it to the CNS.

Motor (efferent) neurons do the opposite; they *originate in the CNS and are relayed to the muscles to contract or glands to release secretions*

Spinal Cord

- The spinal cord is a *long, thin, tubular structure made of nervous tissue that extends from the medulla oblongata in the brainstem to the lumbar region of the vertebral column*.
- It *connects the brain to the body* and is responsible for *transmitting signals back and forth between the brain and the peripheral nervous system*.

Peripheral Nervous System (PNS)

- The PNS includes all the *nerves that branch out from the brain and spinal cord and extend to other parts of the body, including the limbs and organs*.
- The PNS is divided into the *somatic nervous system* and the *autonomic nervous system.*

Somatic Nervous System

Controls *voluntary movements of the skeletal muscles*. It also *receives sensory* information from the sensory organs and transmits it to the CNS.

Autonomic Nervous System (ANS)

Regulates *involuntary body functions*, such as blood flow, heartbeat, digestion, and breathing. The ANS is further divided into the:

- *Sympathetic nervous system* (prepares the body for "fight or flight")
    - e.g.: heart beats faster
- and the *parasympathetic nervous system* (restores the body to a state of calm).
    - e.g.: heart slows to its normal rate

Common Conditions Affecting the Nervous System

Parkinson's Disease –

- A progressive nervous system disorder that affects movement.
- It's characterized by tremors, stiffness, and slowness of movement. Tremors, muscle rigidity, slow movements, balance problems, and changes in speech and writing.

Bell's Palsy –

- paralysis and loss of sensation to one side of the face. Triggered by stress, diabetes, and viruses.
- Produces a characteristic paralysis and loss of sensation to one side of the face. It comes from compression or swelling of the facial nerve.
- Its exact cause is unknown, but the triggers include pregnancy, stress, diabetes mellitus, and viral infections.

Cerebrovascular accident or stroke –

- A *blockage of blood flow (from a thrombus or a hemorrhage) to the brain areas*, which results in less oxygen supply (or hypoxia).
- Resulting in sensory and motor deficits in the face and limbs and limbs supplied by the hypoxia area of the brain.
- Symptoms highly suggestive of stroke are facial asymmetry, slurring of speech, and sudden weakness.

ALS (Amyotrophic Lateral Sclerosis)

- is a disorder of the CNS that causes progressive musculoskeletal paralysis

Seizures

- Abnormal transmission of electrical impulses due to electrolyte imbalances, infections, fever (benign seizures of childhood), or traumatic injury to the brain. Recurring seizures are termed *Epilepsy.*

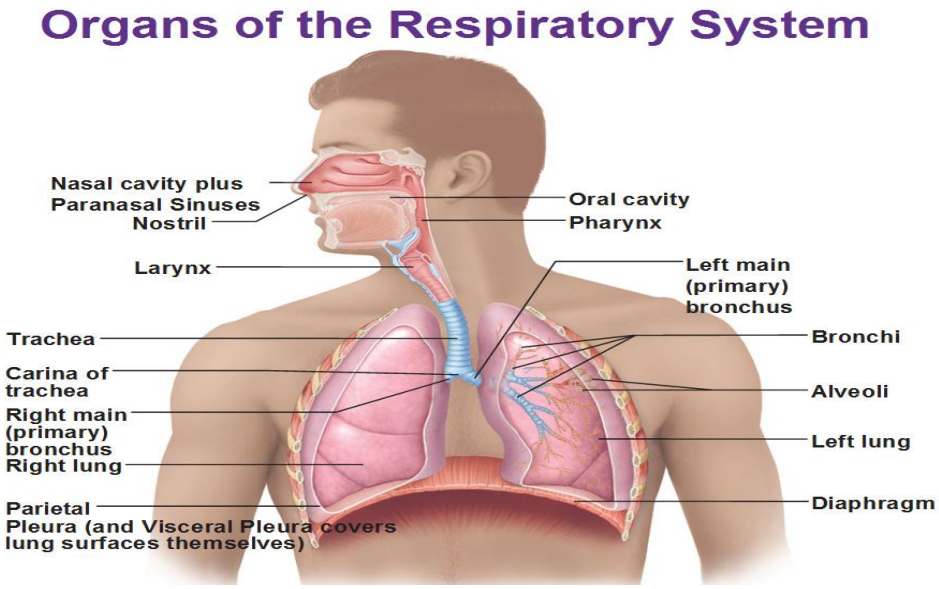
Meningitis

- Swelling of the meninges.
- Meningococcal Meningitis from Neisseria meningitides is highly contagious.

Varicella-Zoster

- a virus that often lies dormant within the peripheral nerves. During the period of immunosuppression, it can reactivate and cause a condition known as *shingles or herpes zoster*.
- This condition is marked by *painful blisters along a dermatome*, an area supplied by the nerve.
- This is contagious and causes unvaccinated individuals to develop chicken pox, not shingles.

The Respiratory System



The system that allows *for gas exchange (ventilation*).

- Its primary function is to supply the blood with oxygen so that the blood can deliver oxygen to all parts of the body through a process called *respiration*.

The respiratory system does this through *breathing: inhaling oxygen-rich air and exhaling air filled with carbon dioxide,* which is a waste product of metabolism.

The respiratory system includes the nose, airway, lungs, and alveoli.

The *Carina* separates the upper and lower tracts of the respiratory system.

Internal respiration – Occurs as gases are exchanged at the level of the *red blood cells and internal organs.*

- These gases circulate through the body through the red blood cells.
- They bind specifically to a molecule in these cells called *hemoglobin.*

Oxygenated blood carries oxyhemoglobin.

- Only about *20% of carbon dioxide* is carried as *carboxyhemoglobin*. The other 80% *combines with water* to form *bicarbonate ions* circulating through the plasma.

As these ions reach the lungs, a chemical reaction allows the carbon dioxide to separate from bicarbonate and bind to the red blood cells.

At the alveoli branches, in the lungs, the carbon dioxide is separated from the RBCs and is released during exhalation.

The level of *circulated oxygen (PO2)* and *carbon dioxide (PCO2)* are measured from *arterial blood as partial pressures*.

The *partial pressure* of oxygen should be *higher in arterial blood* as it functions as the outlet for oxygenated blood.

An analysis of arterial blood gases *also generates a measurement of the pH*.

Adequate respiration ensures the proper levels of gases in the body.

When *respiration is impeded*, carbon dioxide is inadequately released, the buildup of which results in a *decreased blood pH or respiratory acidosis*.

The body compensates by *increasing the rate of breathing*.

When this *hyperventilation* persists, *respiratory alkalosis* may occur as carbon dioxide is rapidly blown out.

Take note:

- During venipuncture, a patient may become anxious.
- Anxiety may produce a *sympathetic nervous response* observed as *increased heart rate and respiratory (or hyperventilation).*
- The respiratory system includes the *nose, airways, lungs, and alveoli*.
- It is separated into the *upper and lower tracts at the level of the carina*.
- Each component performs crucial functions for effective respiration, although ventilation primarily occurs at the alveoli level.

Common Conditions Affecting the Respiratory System

- The respiratory system, essential for gas exchange and oxygen delivery to tissues, can be affected by a range of conditions. These can range from acute infections to chronic diseases, affecting the airways, lung tissue, and the ability to breathe effectively.

Asthma

- A chronic inflammatory disease of the airways characterized by recurrent episodes of wheezing, breathlessness, chest tightness, and coughing, particularly at night or early in the morning.
- These symptoms are usually associated with swelling of the small airways of the lungs and can be triggered by allergies, exercise, or smoke.

Chronic Obstructive Pulmonary Disease (COPD)

- A group of lung diseases that develop over time, that *block airflow making it difficult to breathe*.
- The two main types of COPD are *emphysema and chronic bronchitis*.

Emphysema

- involves *damage to the alveoli* (air sacs) in the lungs, while *chronic bronchitis is characterized by a long-term cough with mucus*.

Pneumonia

- An *infection* that inflames the alveoli in one or both lungs, which may fill with fluid or pus, causing cough with phlegm or pus, fever, chills, and difficulty breathing. This may cause *O2 saturation to decrease*.

Tuberculosis (TB)

- A *chronic lung infection caused by Mycobacterium tuberculosis bacteria.* The bacteria that cause TB are *spread from one person to another through tiny droplets released into the air via coughs and sneezes.*

Sleep Apnea

- A sleep disorder in which *breathing repeatedly stops and starts during sleep*. Common symptoms include snoring loudly and feeling tired even after a full night's sleep.
- *Obstructive sleep apnea* occurs in obese patients when the weight on their neck obstructs their upper respiratory tract.

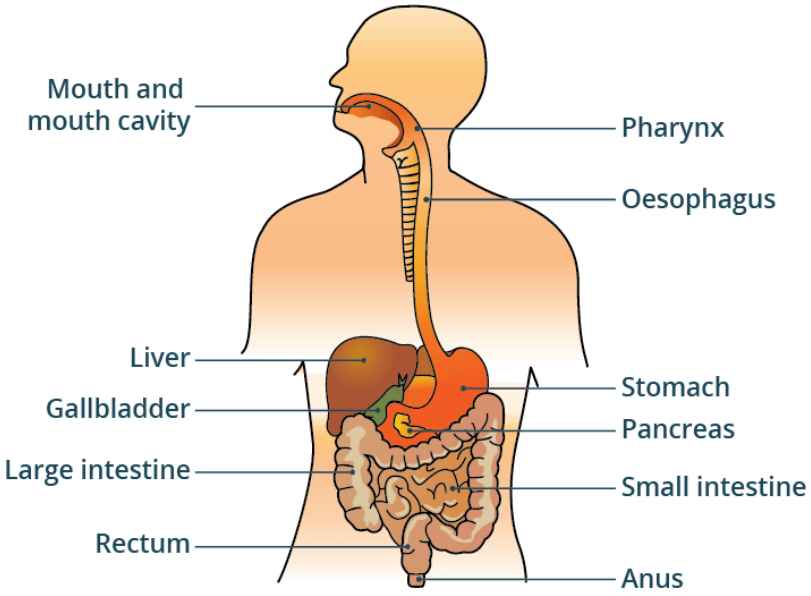
Pertussis

- Causes a characteristic *loud "whooping" cough*, fever, and colds in unvaccinated and susceptible individuals, especially *infants under six months old*. Its causative agent is *Bordetella pertussis bacteria*.
- *Immunization* of health care staff and those living and working around infants is highly recommended.

URTI

- Refers to an infection (either viral or bacterial) involving the organs of the upper respiratory tract. This includes the *common cold.*

The Gastrointestinal System



The gastrointestinal (GI) system, also known as the *digestive system*, is a group of organs and structures *responsible for the intake, breakdown, absorption of nutrients, and elimination of waste from the body.*

- Its role is to maintain overall health by ensuring that the *body receives the necessary nutrients from food and drinks.*

Components of the Gastrointestinal System

1. *Oral Cavity* – where digestion begins. By mastication (chewing) food is digested by the teeth and saliva.
2. *Pharynx:* A muscular tube that connects the mouth to the esophagus. It serves as a pathway for the movement of food and liquids.
3. *Esophagus:* A muscular tube that conveys food and liquids from the pharynx to the stomach through peristaltic movements.
4. *Stomach*: A hollow organ that holds food while it is being mixed with stomach enzymes and acids. These digestive fluids continue the chemical breakdown of food and destroy pathogenic organisms into a usable form *(chyme*).
    a. (*H-Pylori* stomach bacteria that can survive acids and cause ulcers or stomach cancers)
5. *Pancreas:* Produces *digestive enzymes* and bicarbonate, which are released into the small intestine to aid in the digestion and absorption of nutrients.
    a. The pancreas also has an *endocrine role because it releases insulin* into the bloodstream to regulate blood sugar levels
6. *Gallbladder*: Mixes the fat particles and emulsifies. Secretes *bile* for absorption into the liver.
7. *Small Intestine (Duodenum*): The first part of the small intestine where it mixes with pancreatic juices containing digestive enzymes.
    a. The second part of the small intestine includes the Jejunum and ileum. They transport chyme to the large intestines.
8. *Large Intestine (Colon):* Absorbs water, vitamins, and minerals from the material *that has not been digested* as food and is thus responsible for the formation of solid waste (feces).

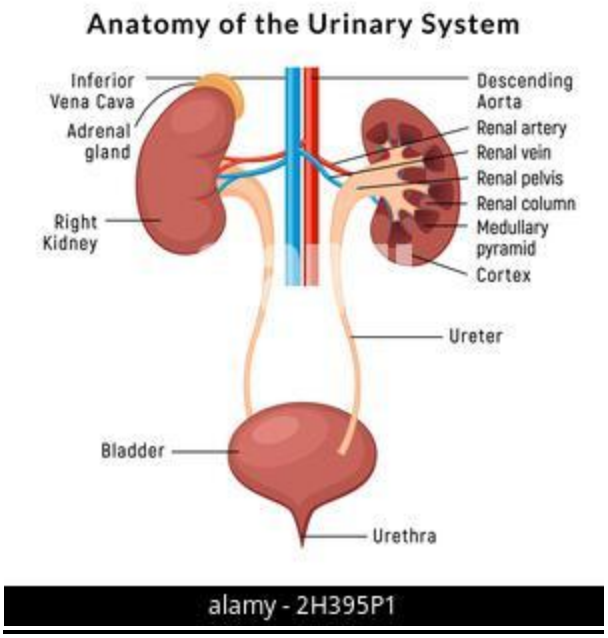
The gastrointestinal system is integral to the body's ability to maintain *homeostasis*, providing cells with nutrients and removing waste products.

Disorders of the GI system can range from common and mild (such as *heartburn and irritable bowel syndrome)* to severe and life-threatening (*such as gastrointestinal cancers and acute pancreatitis).*

Common Conditions Involving the Gastrointestinal System

1. *Peptic (Duodenal) Ulcers*: Open sores that develop on the inside lining of the stomach and the upper portion of the small intestine.
    a. The most common symptom is stomach pain.
    b. Primarily caused by *Helicobacter pylori* bacteria and *long-term use of nonsteroidal anti-inflammatory drugs (NSAIDs*).
    c. Stress and spicy foods *do not cause peptic ulcers* but can worsen symptoms.
2. *Irritable Bowel Syndrome (IBS):* A common disorder that affects the large intestine, causing cramping, abdominal pain, bloating, gas, diarrhea, constipation, or both.
3. *Cholecystitis:* Swelling of *the gallbladder wall* commonly caused by gallbladder or bile duct stones, parasites *(worms, Ascaris, liver flukes*), or tumors.
    a. It may complicate the obstruction of the common *bile duct (cholangitis)* requiring urgent surgical attention.
4. *Cirrhosis*: Degeneration of hepatic cells, or attacks on the liver (hepatitis viruses, alcohol, toxins, or tumors).
5. *Gastroenteritis:* Inflammation of the gastrointestinal tract.
    a. Known as *diarrhea or loose stools*. Abdominal pain, nausea, and vomiting can also be associated with this. It can be caused by various microorganisms.
6. *Hernia:* Abnormal *protrusion of a part of an organ through the body cavity* that has lost its integrity, such as an inguinal hernia from the protrusion of the mesentery into the inguinal canal.
7. *Pancreatitis*: Excruciating pain from *inflammation of the pancreas*. This may be due to excessive alcohol intake, gallbladder stones, cancer, or surgical complications.

The Urinary System

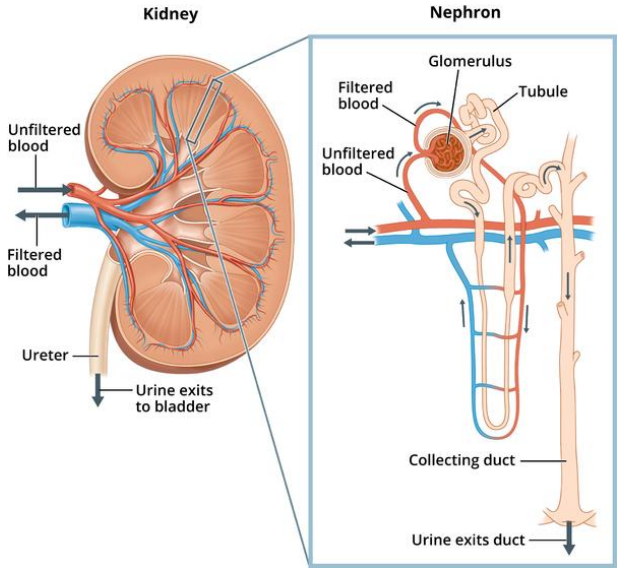


The urinary system, is also known as the *renal system*. Is responsible for the production, storage, and elimination of urine.

It is also important in maintaining the body's chemical balance, regulating blood pressure, and removing waste products and excess substances.

It is composed of the *kidneys, ureters and urethra*.

Parts of the Urinary System



1. *Kidneys:* A pair of *bean-shaped* organs located below the ribs toward the middle of the back; they contain over a million nephrons each.

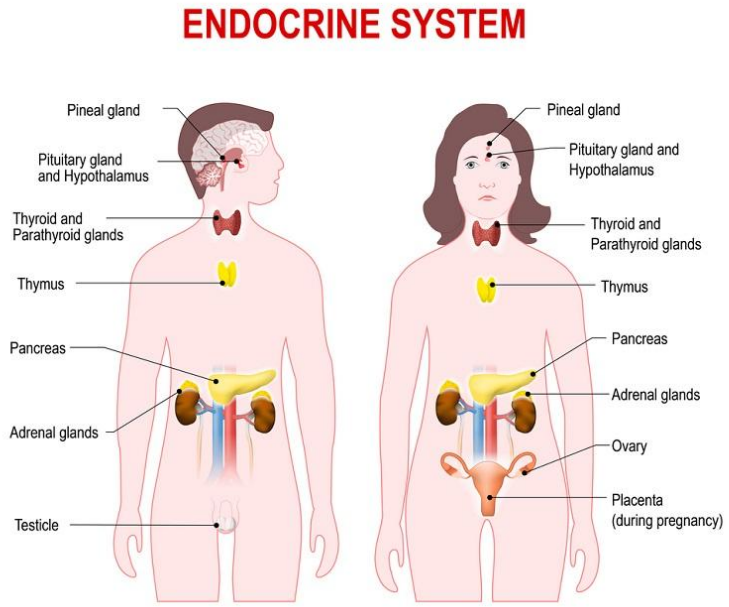
2. *Nephrons* work to filter blood, keeping needed water, glucose, hydrogen, bicarbonate ions, and electrolytes creating a *homeostasis* environment.
    a. The nephrons then remove waste products and excess water, electrolytes, and toxins. Once the blood leaves the nephrons, it goes through a *bundle of capillaries called the glomerulus.*
3. *Glomerulus* filters out smaller substances while keeping larger ones like protein and RBCs., converting these to urine.
    a. This passes from each kidney to the paired *ureters.* It is stored in the *bladder* until the detrusor muscles contract to allow for *micturition* (or urination).
    b. Kidney function is estimated through the *glomerular filtration rate*, which should be 90 to 120 ml/min/1.73m2.
    c. This means all the blood travels through the kidney's filtration system about 40 times a day.
4. *Creatinine*: Is a substance that is excreted in the urine.
    a. The kidneys also have *endocrine functions*.
    b. They produce *renin*, which is involved in *blood pressure regulation*, and *erythropoietin,* which signals the bone marrow to produce red blood cells.
    c. The kidneys are also responsible for converting *exogenous vitamin D* (from the sun or diet) into its active bioavailable form.

Common Conditions of the Urinary Tract

1. *Cystitis* – Inflamed urinary tract
2. *Pyelonephritis* – inflamed renal pelvis
3. *Urinary tract infection* - bacterial infection of the urinary tract
4. *Nephrolithiasis – Kidney stones*. Caused by an increase in uric acid or calcium in the blood, which impedes proper blood filtering in the kidneys. It can be painful and may need surgical intervention to treat.
5. *Renal failure* - loss of renal function to one or both kidneys. *Uremic* blood has too much urea and metabolic waste.
    a. The term for a permanent surgical connection between an artery and a vein is called an arteriovenous fistula, or AV. The fistula's blood flow avoids capillaries and moves directly from an artery into a vein.
6. Fistulas usually occur in legs, but they can develop most anywhere.

a. With dialysis, people with severe kidney disease may have a fistula surgically created in their forearm.

The Endocrine System



The endocrine system is a network of glands and organs that produce, store, and *secrete hormones* into the bloodstream. The endocrine system works in concert with the nervous system to control functions ranging from metabolism, sleep, stress, reproduction, and mood regulation.

- The *hypothalamus* produces and secretes hormones.
- The *feedback system* allows hormones to increase or decrease depending on the number of hormones the body needs.

The main glands of the Endocrine System

- *Anterior Pituitary Gland*: Often termed the "*master gland*," It's located at the base of the brain.
    - Signaled by the *hypothalamus*, secretes a stimulating hormone that helps other endocrine glands to secrete their hormones. This helps control functions such as growth, blood pressure, and reproduction.

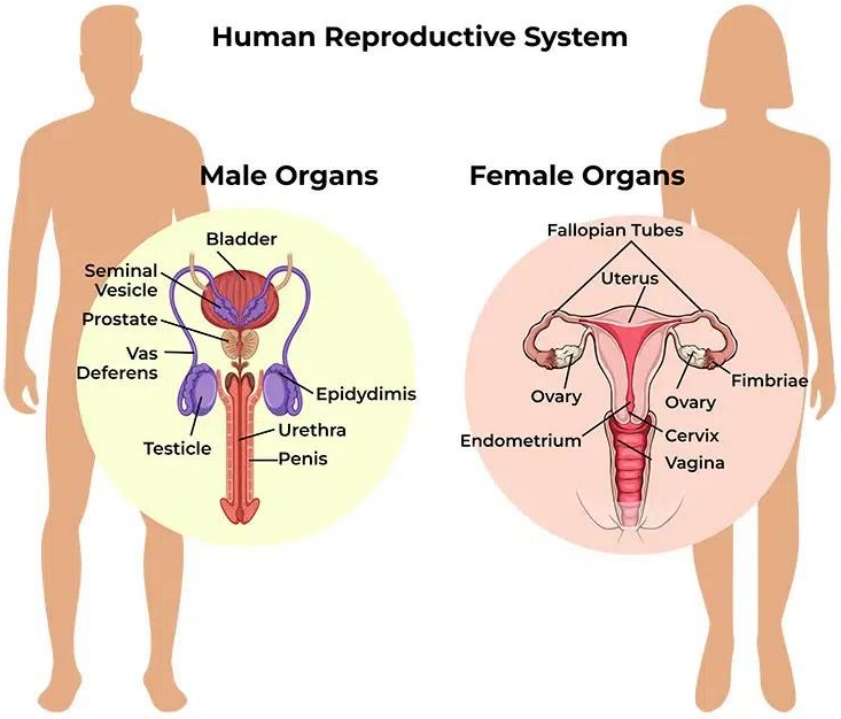
- *Thyroid Gland*: Located in the neck, it produces *thyroxine and triiodothyronine*, hormones that regulate metabolism, energy production, and the body's sensitivity to other hormones.
- *Parathyroid Glands*: Small glands located on the posterior surface of the thyroid gland, regulate calcium and phosphate balance in the body.
- *Adrenal Glands*: Located on top of each kidney,
- *Adrenocortica*l - (*aldosterone*) affects blood pressure, and maintains calcium and potassium levels. (*cortisol*) response to stress, anti-inflammation, and metabolism.
- *Medullary* – (*epinephrine and norepinephrine*). Response to increased heart rate, activity, stress, responsible for vasoconstriction in increasing blood pressure.
- *Estrogen and androgens* responsible for sexual development
- *Pancreas:* An organ located in the abdomen; it has *both digestive and hormonal functions*. It produces *glucagon (Catabolic*), which regulates blood sugar levels, and *Insulin* which decreases blood sugar levels (*Anabolic)* and stores glucagon in blood cells
- *Testes:* In males, they produce sperm and testosterone, which regulate sperm production, libido, and secondary sexual characteristics.
- *Posterior pituitary gland*: (*antidiuretic hormone*) regulates kidneys to reabsorb water and maintain hydration. (*Oxytocin*) stimulates the uterus to contract and mammary glands to secrete milk.
- *Thymus*: Stimulates the maturation of *T cells*; responsible for developing the immune system; atrophies in adults.
- *Pineal gland*: Regulates the circadian rhythm; stimulated by darkness and allows sleep to occur.

Common Conditions Affecting the Endocrine System

- *Type 1 Diabetes*: An autoimmune condition where the pancreas produces little or no insulin.
- *Type 2 Diabetes*: More common, resulting from the body's ineffective use of insulin, often associated with obesity and lifestyle factors.
- *Hyperthyroidism*: Caused by excessive thyroid hormone production, resulting in weight loss, rapid heartbeat, and heat intolerance.

- *Goiter*: Enlargement of the thyroid gland, which can result from iodine deficiency or thyroid disease.
- *Acromegaly*: A condition resulting from the excessive secretion of growth hormones. Progressive and noticeable enlargement of extremities like hands and feet.
- *Diabetes insipidus*: Inadequate levels of antidiuretic hormones.
- *Dwarfism*: Lack of growth hormone during development.
- *Congenital hypothyroidism*: Observed in infants with impaired thyroid function due to a genetic disorder or maternal iodine deficiency.
- *Diabetes mellitus*: Increased blood sugar due to insulin deficiency or the inability of cell membrane receptors to recognize insulin.
- *Addison's disease*: (adrenal insufficiency) Glands do not secret sufficient cortisol and aldosterone.
- *Cushing disease*: Excessive secretion of adrenocorticotropic hormone, which results in excessive cortisol levels.

The Human Reproductive System



The reproductive system is essential for human reproduction and consists of both external and internal organs that work together for procreation.

The system is divided into two main parts: the *male reproductive system* and the *female reproductive system*, each with specific functions and structures.

The Male Reproductive System

- The male reproductive system is designed to produce, maintain, and transport sperm — the male reproductive cells, and protective fluid (semen).
- It also discharges sperm into the female reproductive tract during sex.

Main parts of the Male Reproductive System

- *Testes (Testicles*): Produce sperm and testosterone, the male sex hormone.
- *Scrotum:* A pouch of skin containing the testes, regulating their temperature.
- *Epididymis*: Stores sperm cells and is where they mature.
- *Vas Deferens*: Tubes that transport mature sperm to the urethra in preparation for ejaculation.
- *Prostate Gland*, *Seminal Vesicles, and Bulbourethral Glands*: Produce fluids that nourish and transport sperm (semen).
- *Penis*: Delivers semen into the female reproductive tract.

The Female Reproductive System

- The female reproductive system is designed to produce eggs (ova) for fertilization and to provide a place to support the development of offspring.

Main parts of the Female Reproductive System

- *Ovaries*: Produce eggs and hormones including estrogen and progesterone.
- *Fallopian Tubes*: Transport the eggs from the ovaries to the uterus. Fertilization of an egg by sperm typically occurs here.
- *Uterus (Womb):* A hollow organ where a fertilized egg can develop into a fetus.
- Cervix: The lower part of the uterus that opens into the vagina.

- *Vagina (Birth Canal):* A canal that connects the cervix to the external body, serving as the passageway for menstrual blood, sexual intercourse, and childbirth.

Common Conditions Affecting the Reproductive System

Sexually Transmitted Infections (STIs)

- Chlamydia trachomatis (chlamydia)
- Trichomonas vaginalis (trichomoniasis)
- Treponema (syphilis)
- Herpes simplex virus (Herpes genitalis)
- Neisseria gonorrhea (gonorrhea)
- *Pelvic inflammatory disease*: An infection that affects the organs of reproduction and may cause infertility or septicemia.
- *Endometriosis:* Abnormal implantation of endometrial tissue outside the uterus.

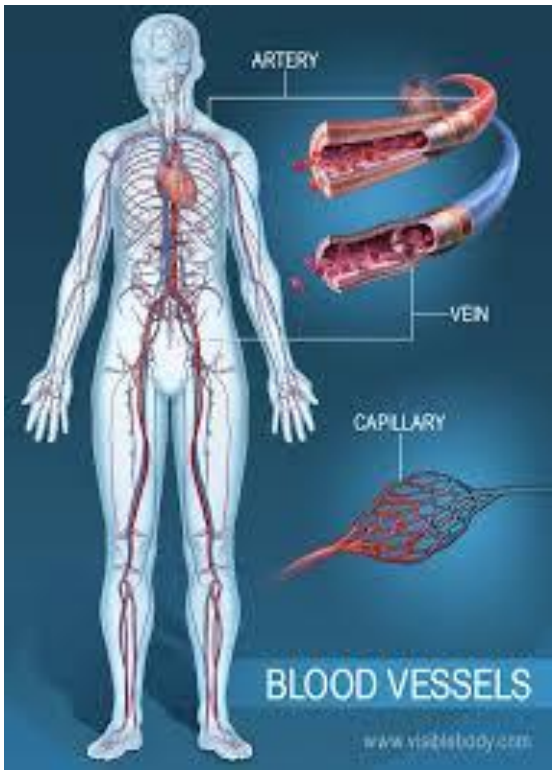
To diagnose, evaluate, and manage conditions affecting the reproductive system, healthcare providers may order a variety of tests. These tests help assess the function and integrity of the reproductive organs, hormone levels, and identify any abnormalities.

The Circulatory System

The circulatory system, also known as the cardiovascular system, is a complex network that plays a vital role in maintaining homeostasis and supporting life. It consists of the heart, blood vessels, and blood, and it functions to transport oxygen, nutrients, hormones, and waste products throughout the body.

The Vasculature

These are the blood vessels that act as highways for blood cells.



Arteries

- Carry oxygen-rich blood away from the heart to the body's tissues, except for the pulmonary arteries, which carry oxygen-poor blood to the lungs.
- Arteries are typically oxygenated (*an exception is the pulmonary artery*).
- They branch to form *microscopic-sized arteries called arterioles*.
- *Both arteries and arterioles carry and distribute oxygen*.

Veins

- Return oxygen-poor blood to the heart, except for the pulmonary veins, which carry oxygen-rich blood from the lungs to the heart.

Capillaries

- Tiny blood vessels that form a network between arteries and veins, facilitating the exchange of oxygen, nutrients, and waste products between blood and tissues.
- *Petechiae* - Ruptured capillaries, are tiny red spots that can appear on the skin, conjunctiva (the inside of eyelids), retina, and mucous membranes.

Blood

- A fluid that circulates through the heart, arteries, veins, and capillaries. It comprises plasma (the liquid component), red blood cells (carry oxygen), white blood cells (part of the immune system), and platelets (involved in clotting).

The 3 layers of Blood vessel walls

1. Tunica adventitious – made up of connective tissue, outer layer
2. Tunica media – muscular and elastic, middle layer
3. Tunica intima- made of endothelium, inner layer (endocardium)

Functions of the Circulatory System

1. Transportation: *Carries oxygen* from the lungs to the body's cells and transports carbon dioxide from the cells to the lungs for exhalation.
    a. It also *moves nutrients* from the digestive system to the cells, *carries waste products* to the kidneys for excretion, and transports hormones from the endocrine glands to their target organs.
2. Regulation: Helps regulate *body temperature* by distributing heat produced in the muscles and other areas to the skin, where it can be dissipated.
    a. It also helps maintain the pH balance and electrolyte composition of body fluids.
3. Protection: Blood *contains cells and antibodies* of the immune system that protect the body against pathogens.
    a. Platelets and certain plasma proteins form clots to seal wounds and prevent blood loss.

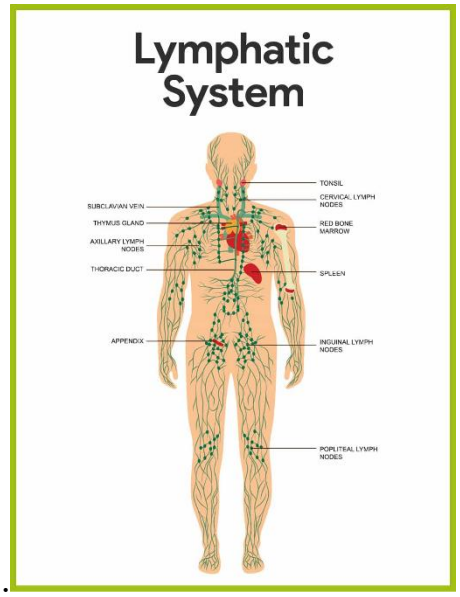
Common Conditions Affecting the Circulatory System

- Hypertension (High Blood Pressure): A condition where the force of the blood against the artery walls is too high, increasing the risk of heart disease and stroke.
- Coronary Artery Disease (CAD): is characterized by the buildup of plaque in the coronary arteries, reducing blood flow to the heart muscle.
- Heart Attack (Myocardial Infarction): Occurs when blood flow to a part of the heart is blocked for a long enough time that part of the heart muscle is damaged or dies.
- Stroke: Happens when the blood supply to part of the brain is interrupted or reduced, preventing brain tissue from getting oxygen and nutrients.

- Heart Failure: A chronic condition where the heart doesn't pump blood as well as it should.
- Arrhythmias: Irregular heartbeats that can affect how effectively the heart pumps blood.
- Peripheral Artery Disease (PAD): A circulatory condition where narrowed blood vessels reduce blood flow to the limbs.

The health of the circulatory system is essential for overall wellness, and maintaining a healthy lifestyle can help prevent many circulatory system disorders. Regular exercise, a balanced diet, avoiding tobacco use, and managing stress are critical steps in supporting cardiovascular health.

The Lymphatic System



Lymphatic tissues — the spleen, thymus, lymph nodes, and other organs — produce lymphocytes.

Platelets(thrombocytes), contributes to blood clotting, preventing excessive bleeding.

Plasma, comprising water, electrolytes, proteins, hormones, and waste products, acts as a medium for the transportation of nutrients and metabolic by-products.

Chapter 11: The Heart

The Heart

The heart is a muscular organ located in the thoracic cavity. Its primary function is to pump blood throughout the body, delivering essential oxygen and nutrients to tissues and organs while removing waste products.

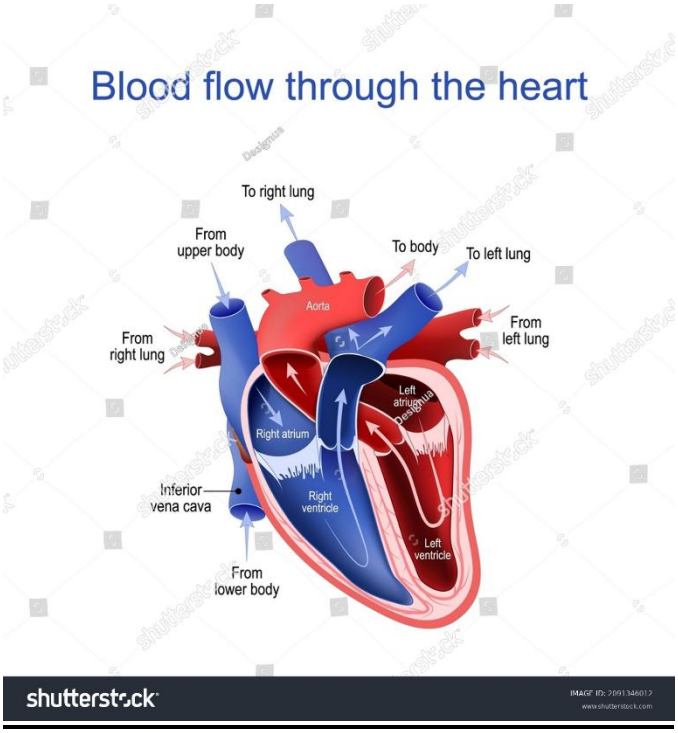
Anatomy of the Heart

The heart is about the size of a closed fist and is divided into four chambers: two atria and two ventricles.

The ***right atrium*** receives deoxygenated blood from the body and pumps it into the ***right ventricle***, which then sends the blood to the lungs for oxygenation. The oxygenated blood returns to the ***left atrium*** and passes through the ***left ventricle***, and is pumped to the rest of the body.

The *pulmonic valve* belongs to the type called "*outflow*" valves.

Separates the *right ventricle* from the *pulmonary artery*, the pulmonic valve opens so that blood from the right ventricle can be pumped to the lungs, here it picks up oxygen. To prevent blood back-flow from the pulmonary artery, the pulmonic valve has three flaps (cusps) that close (or contract) before repeating the process.



Physiology of the Heart

The heart's rhythmic contractions are known as the *cardiac cycle*.

The SA node, often referred to as the "natural pacemaker," initiates the heartbeat, causing the atria to contract. The electrical signal then travels to the AV node, which delays the impulse briefly before transmitting it to the ventricles, ensuring a coordinated contraction sequence.

The cardiac cycle involves two main phases: systole and diastole.

During systole, the heart contracts, pumping blood into the arteries.

Diastole, on the other hand, is the relaxation phase, allowing the chambers to fill with blood before the next contraction.

The heart's ability to adjust its rate and force of contraction based on the body's demands is regulated by the autonomic nervous system, specifically through the sympathetic and parasympathetic branches.

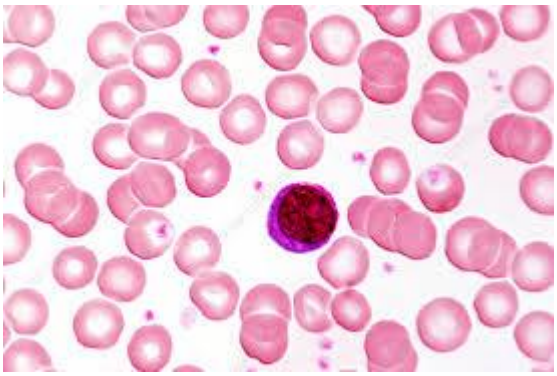
Blood

serves as a lifeline, delivering essential nutrients, oxygen, and hormones to various organs and tissues. Comprising red and white blood cells, platelets, and plasma, blood is a dynamic and complex substance with a plethora of functions.

Composition of Blood

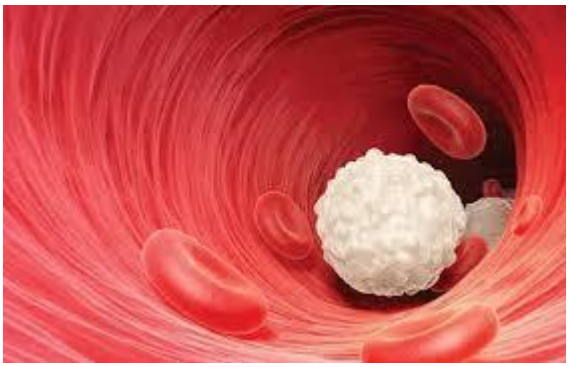
Blood is a specialized connective tissue that consists of various cellular and non-cellular components. The cellular components include red blood cells (erythrocytes), white blood cells (leukocytes), and platelets (thrombocytes), while plasma, a straw-colored liquid, constitutes the non-cellular portion.

Each component plays a unique role in maintaining the equilibrium of the internal environment.



Red blood cells (erythrocytes), predominantly composed of hemoglobin, facilitate the transport of oxygen and carbon dioxide.

- RBCs pass through the spleen and liver prior to their death — at *about 120 days* — at which time the liver's macrophages "undergo a process called phagocytosis" and digest the spent cells.



White blood cells(leukocytes), are crucial components of the immune system, defending the body against infections and foreign invaders.

- White blood cells make up about one percent of total blood volume. A high volume of leukocytes often indicates the body is fighting disease or infection.
- Approximately 20–40% of WBC are lymphocytes. The lymphocytes consist of *T cells and B cells.*
- *Bone marrow* stores approximately 80–90% of WBC, but they are released when an inflammatory condition or an infection occurs.
- White blood cells work to recognize and protect the body against infections by producing *proteins (antibodies*) to fight infections.

Basophils are small cells that recognize an allergic reaction, at which time they secrete antihistamine.

Functions of Blood

Blood performs a myriad of vital functions that are essential for the survival of the human body.

Oxygen transport is one of its primary functions, facilitated by red blood cells. These cells bind with oxygen in the lungs and release it in tissues, ensuring cellular respiration.

Nutrient transport, delivering nutrients absorbed from the digestive system to cells throughout the body.

White blood cells, the immune system relies on blood to detect, and eliminate pathogens, viruses, and abnormal cells.

Blood clotting is another critical function, preventing excessive bleeding in response to injuries.

Blood acts as a regulator of *body temperature, pH levels, and fluid balance*, contributing to the overall homeostasis of the internal environment.

Hemostasis, the process in which the body repairs a damaged blood vessel to prevent further loss of blood, begins with the vascular stage.

Fibrinolysis is the process that removes clots following hemostasis.

The normal body process of breaking down and removing a clot is *primary fibrinolysis*. *Secondary fibrinolysis* occurs with medication, a medical disorder, or another cause.

Common blood-related conditions

Anemia

- occurs when there is a decrease in the number of red blood cells or a low concentration of hemoglobin in the blood. This can result from nutritional deficiencies (such as iron, vitamin B12, or folic acid), chronic diseases, or genetic conditions.
- Symptoms may include fatigue, weakness, and paleness.

Hemophilia

- is a genetic disorder that affects blood clotting. People with hemophilia have a deficiency or absence of clotting factors, leading to prolonged bleeding after injuries or surgeries.
- There are different types of hemophilia, and the severity varies.

Leukemia

- is a type of cancer that affects the blood-forming tissues, primarily the bone marrow and lymphatic system. It leads to the overproduction of abnormal white blood cells, interfering with the normal functioning of the immune system.
- Symptoms include fatigue, frequent infections, and unexplained weight loss.

Thrombocytopenia

- is a low platelet count, leading to an increased risk of bleeding and bruising.
- It can be caused by various factors, such as autoimmune disorders, medications, infections, or bone marrow disorders.

Polycythemia vera

- is a rare blood disorder caused by the overproduction of red blood cells in the bone marrow.
- This can lead to an increased risk of blood clots, strokes, and other cardiovascular complications.

Sickle cell disease

- is a genetic disorder that causes red blood cells to become misshapen and break down more easily.
- This can lead to anemia, pain, and organ damage. Individuals with sickle cell disease may experience episodes of pain (crises) and have a shortened lifespan for their red blood cells.

Deep Vein Thrombosis (DVT) and Pulmonary Embolism (PE)

- occurs when a blood clot forms in a deep vein, usually in the legs.
- If a part of the clot breaks off and travels to the lungs, it can cause a pulmonary embolism.
- Both conditions can be life-threatening and require prompt medical attention.

Hypertension (High Blood Pressure)

- can have significant effects on the blood vessels.
- Chronic high blood pressure can damage blood vessels, increasing the risk of heart disease, stroke, and other cardiovascular complications.

Hemochromatosis

- is a genetic disorder that leads to excessive iron absorption by the body.
- Over time, this can result in iron overload, affecting various organs and tissues and causing complications such as liver damage, diabetes, and heart problems.

Idiopathic Thrombocytopenic Purpura (ITP)

- is an autoimmune disorder in which the immune system mistakenly attacks and destroys platelets.
- This can result in a low platelet count and an increased risk of bleeding.

Coagulation

Coagulation is the process by which blood forms clots to stop bleeding. It is a complex and highly regulated sequence of events that involves the interaction of various proteins in the blood known as clotting factors. The coagulation process is crucial for preventing excessive bleeding when blood vessels are injured.

The primary components involved in coagulation are platelets and clotting factors.

- Platelets are small cell fragments in the blood that play a key role in forming the initial plug at the site of injury.
- Clotting factors are proteins, including fibrinogen, prothrombin, and various others, which interact to form a stable blood clot.

3 main phases of the coagulation process:

1. Vasoconstriction and Formation of the Platelet Plug:
    a. When a blood vessel is injured, vasoconstriction occurs to reduce blood flow to the affected area. Platelets adhere to the exposed collagen at the site of injury, become activated, and release chemicals that attract more platelets. This forms a temporary plug to stop immediate bleeding.
2. Coagulation Cascade:
    a. Involves a series of enzymatic reactions that lead to the activation of clotting factors. This change results in the conversion of fibrinogen into fibrin, which forms a mesh that stabilizes the platelet plug, creating a more robust blood clot.
3. Clot Retraction and Repair:
    a. After the stable blood clot is formed, the clot retracts to reduce its size. This process is crucial for tissue repair. Eventually, the clot is dissolved through a process called fibrinolysis, ensuring that blood vessels are not unnecessarily occluded.

Hemostasis

Hemostasis refers to the overall process of preventing and stopping bleeding. It includes three main components: vascular spasm, platelet plug formation, and coagulation. *Hemostasis* is a dynamic and intricate system that maintains the delicate balance between preventing excessive bleeding and avoiding unnecessary clot formation.

Vascular Spasm:

- -When a blood vessel is injured, the immediate response is vasoconstriction or a narrowing of the vessel. This reduces blood flow to the affected area, minimizing blood loss. A vascular spasm is a rapid, temporary constriction that provides the initial response to vessel injury.

Platelet Plug Formation:

- Platelets play a crucial role in the formation of a temporary plug at the site of injury. They adhere to the exposed collagen, become activated, and release chemicals that attract more platelets. This leads to the formation of a platelet plug that seals small breaks in the blood vessel wall.

Coagulation:

- Coagulation is the final stage of hemostasis, where the formation of a stable blood clot occurs. The coagulation cascade involves a series of sequential steps that lead to the conversion of fibrinogen into fibrin, reinforcing the platelet plug and creating a more durable clot.

The regulation of hemostasis is essential to prevent both excessive bleeding and inappropriate clotting. Imbalances in hemostasis can lead to conditions such as bleeding disorders (hemorrhagic disorders) or thrombosis (excessive clot formation), both of which pose significant health risks.

Chapter 12: Basic Blood Collection Materials

Blood Collection

Blood collection is a fundamental aspect of healthcare diagnostics and research, requiring careful attention to detail and the use of specialized materials to guarantee accurate results and ensure the safety of both healthcare providers and patients.

- The materials used in blood collection play a pivotal role in maintaining the integrity of blood samples, preventing contamination, and safeguarding the well-being of patients and healthcare providers.

Vacutainer Holder

- Holds blood collection tubes to aid with blood collection

Needles and Syringes

- Sterile needles and syringes draw blood from the patient's vein. 18 gauge is used for drawing blood; however, *only registered nurses and doctors can give blood.* The 21, 22, and 23 gauges are used strictly for the phlebotomy technician.
- 27-gauge needle - used for subcutaneous injections for medications such as insulin or heparin, as well as for intradermal uses such as the TB vaccine

- Serves as the primary tool for accessing veins and drawing blood. Advancements in needle technology have led to the development of various types, each designed for specific applications.
- The gauge and length of the needle are tailored based on factors such as the patient's age, the size of the target vein, and the volume of blood required.

- The butterfly should be reserved for fragile veins. The butterfly tends to decrease blood flow, they are relatively expensive, and choosing the right size requires many considerations.
- Safety features, such as retractable needles, have also been introduced to reduce the risk of needlestick injuries and enhance overall safety.

Antiseptic Solution

- An antiseptic solution, typically 2% chlorhexidine or 70% isopropyl alcohol, is used to disinfect the skin at the venipuncture site.

Tourniquet

- A tourniquet is applied proximal to the venipuncture site to facilitate vein visualization and enhance blood flow during collection.

Sterile Gauze and Adhesive Bandage

- Sterile gauze and adhesive bandages are used to cover the puncture site after blood collection to prevent bleeding and reduce the risk of infection.

Personal Protective Equipment (PPE)

- Healthcare providers should wear appropriate PPE, including gloves and, if necessary, gowns, to prevent exposure to bloodborne pathogens.

Blood Culture Bottles

- Blood culture bottles are sterile containers designed to collect and support the growth of microorganisms present in the bloodstream.
- Aerobic and anaerobic bottles are commonly used to cater to different types of microorganisms.

- **BacT/Alert SA (Aerobic) with oxygen**
- **Bottle BacT/Alert SN (Anaerobic) without oxygen**
- **Bottle BacT/Alert PF (Pediatric)**

- Each bottle contains an internal colorimetric sensor on the bottom that detects carbon dioxide
- Measures bacterial growth.
- If bacteria are present in the patient's blood, they will produce CO2, and the sensor will change from blue-green to yellow

- Store all media at room temperature.
- Observe the expiration date.

Frequency of Blood Cultures:

- *Acute sepsis, meningitis, pneumonia*
    - 1-2 samples from separate sites before treatment
- *Continuous bacteremia and suspected endocarditis*
    - Draw 3 samples from separate sites and begin therapy. If all are negative 24 hours later, obtain 3 more samples
- *For antimicrobial therapy*:
    - Samples collected before the next dose of antibiotic.
- *Fever of unknown origin* (FUO)
    - Draw 2 - 3 separate initial samples. Obtain 2 more samples after 24 to 36 hours.

Additional Notes:

- Rarely more than 3 sets of cultures are necessary
- Cultures are drawn before antimicrobial therapy initiated
- Max 3 sets of blood cultures per 24 hours or febrile episode
- Consult with the Director of the microbiology lab if the physician requests more sets

Duration of incubation of Blood Culture specimens

- Test time: 5 days.
- 21 days for suspected yeast

Blood Specimen Volume (amount needed for testing)

- *Adult:* Up to 20ml blood of normally sterile body fluid (10m each bottle_
- *Pediatric:* Up to 4ml blood

*If only enough blood has been drawn to fill one bottle, inoculate an *aerobic* bottle

Blood collection tubes

Sterile containers designed to collect, store, and transport blood samples. These tubes come in different sizes and colors, each indicating the presence of specific additives tailored to the type of testing required.

For instance, tubes with EDTA are used for complete blood counts, while tubes containing citrate are employed for coagulation studies.

The use of appropriate tubes with the correct additives is critical to obtaining reliable test results.

Blood collection tubes often contain various additives to preserve the integrity of blood samples and facilitate specific laboratory tests.

The choice of additives depends on the type of test that will be conducted on the collected blood.

Common blood collection tube additives and their purposes:

Anticoagulants:

- Anticoagulants prevent blood clotting by inhibiting coagulation.
- Common anticoagulants used in blood collection tubes include:
    - EDTA (Ethylenediaminetetraacetic acid): Used for complete blood counts (CBC) and blood cell morphology examinations.
    - Heparin: Inhibits thrombin formation and is used for tests such as electrolyte panels and some enzyme assays.
    - Citrate: Binds calcium, preventing the clotting process. Tubes with citrate are commonly used for coagulation studies like prothrombin time (PT) and activated partial thromboplastin time (aPTT).

Clot Activators

- Promote blood clotting and facilitate serum separation by accelerating the clotting process.
- Tubes with clot activators are typically used for tests that require serum.
- Common clot activators include:
    - Silica particles: Enhance clot formation and aid in serum separation.
    - Glass particles: Accelerate the clotting process.

Gel Separators:

- Tubes with gel separators contain a gel at the bottom that forms a barrier between the serum and the cellular components of blood during centrifugation.

- This allows for easy separation of serum from blood cells. Gel separators are commonly used in chemistry panels and serum and other body fluid tests.

Preservatives:

- Some blood collection tubes contain preservatives to maintain the stability of certain analytes over time.
- For example:
    - Sodium Fluoride: Preserves glucose levels by inhibiting glycolysis (breakdown of glucose). Often used in tubes for glucose testing.
    - Boric acid or lithium heparin: Used for tests that require the preservation of certain analytes, such as enzymes or hormones.

Stabilizing Agents:

- Stabilizing agents help maintain the stability of specific analytes in the blood sample. For instance:
- RNA/DNA stabilizers: Preserve nucleic acids for molecular testing.
- Protease inhibitors: Prevent the degradation of proteins in the sample.

Buffering Agents:

- Buffering agents help maintain the pH of the blood sample, ensuring the accuracy of certain tests.
- *Trisodium citrate*: Acts as a buffer (reduces damage) in coagulation studies.
- *Trisodium EDTA*: Also helps in maintaining the pH and preventing coagulation.

Antiglycolytic Agents:

- Antiglycolytic agents inhibit glycolysis, *the breakdown of glucose*, in the collected blood sample.
- This is essential for accurate measurement of glucose levels.
- Sodium fluoride is commonly used as an antiglycolytic agent.

Microbial Inhibitors:

- Some tubes may contain additives to inhibit microbial growth, maintaining the stability of the sample during transportation or storage.

Understanding the specific additives in blood collection tubes is crucial for healthcare professionals to ensure proper sample handling and accurate test results.

Different tubes are designed for specific types of analyses, and choosing the right tube with the appropriate additives is essential for maintaining the quality of blood samples.

Blood Collection Test Description & Tube Type

Differences between red, gold, and green SST blood collection tubes:

- Red tubes: Contain no anticoagulants and are used for serum testing
- Gold tubes: Contain a clot activator and gel to separate serum from cells
- Green tubes: Contain heparin, an anticoagulant that prevents blood from clotting
    - Gold SST tubes are preferred over red stopper tubes for chemistry tests because they contain separation gel, which prevents serum contamination. (Electrolyte Panel (Lytes) Sodium, Potassium, Chloride, CO2)
- SST Tube - Basic Metabolic Panel (BMP) Electrolyte Panel, BUN, Calcium, Creatinine, Glucose
- SST Tube - Comprehensive Metabolic Panel (CMP) Electrolyte Panel, BUN, Calcium, Creatinine, Glucose, Albumin, Alk. Phos., ALT (SGPT), Total Protein, AST (SGOT), Total Bilirubin,
- SST Tube Lipid Panel (LIPID) Cholesterol, HDL Cholesterol, Triglycerides, LDL (calculated)
- SST Tube Hepatic Function Panel (HFP) Albumin, Alk. Phos., AST (SGOT), ALT (SGPT), Direct Bilirubin, Total Bilirubin, Total Protein
- SST Tube Renal Panel (RENAL) Electrolyte Panel, Albumin, BUN, Creatinine, Calcium, Glucose, Phosphorus
- SST Tube Prenatal Panel (PRENP) CBC(Reflex), ABO & Rh (Blood Type), Antibody Screen (Reflex), RPR (Reflex), Rubella, Hepatitis B. Surface Antigen (Reflex)
- SST Tubes Acute Hepatitis Panel (HPABC) Hepatitis An Antibody IgM, Hepatitis B Surface Antigen (Reflex), Hepatitis B Core Antibody IgM, Hepatitis C Antibody

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aerobic and anaerobic set
8-10 ml blood volume

paediatric bottle
1-3 ml blood volume

1. **<u>Blood Culture Bottles</u>** – Used for bacterial and fungal cultures.

Must be drawn first to reduce the potential hazard of bacterial, fungal, and/or any other specimen contamination. For blood cultures with aerobic and anaerobic vials, no waste tubes are used because it may introduce unnecessary oxygen.

Results not impacted by fasting blood sugar

- <u>Aerobic (Blue/ Pink) bottle</u> – Contains enriched Soybean – Casein digest broth medium capable of supporting the growth of aerobic organisms and resins for antibiotic neutralization.
- <u>Anaerobic (Purple) bottle</u>—This bottle contains a Lytic Anaerobic medium designed to increase the detection and recovery of anaerobes. It contains a detergent to lyse red and white blood cells present in the sample, releasing any intracellular organisms.

- Yellow stopper Isolator tubes – Contain a nutrient solution

- Black stopper Isolator tubes – Contain a blood lysis solution

2. **Light blue Top Tube**

Coagulation & Fibrinolysis Coagulation

- APTT (activated partial thromboplastin time) PT (prothrombin time) Antiplasmin Plasminogen, measures the time it takes for an individual's blood to clot.
- TCT (thrombin clotting time)
- D-dimer
- Euglobulin Lysis Time
- Factors (coagulation factor assays)
- Fibrinogen: activity and concentration
- (ELISA antigenic determination)
- Factor II, Factor VII, Factor VIII, Factor IX, Factor X, Factor XI, Factor XII

Tube Contents and Purpose

Sodium citrate as an anticoagulant

- Used for collecting citrated (a salt of citric acid) plasma for coagulation studies

Usage Instructions

- A 1mL of blood must be drawn 1st into a blue top citrate tube, discard the first tube.
- Fill the second tube with at least 2.7 ml of blood
- Immediately invert the tube 3-4 times to mix and ensure proper anticoagulation

- Important to fill the tube with the specified blood volume, under-filled tubes lead to falsely prolonged values due to anticoagulant dilution giving inaccurate results

Volume Guidelines

  - mL collection tube - Requires 2.7 mL of blood, 0.3 mL sodium citrate

Importance of Proper Collection

- Dilution of plasma with anticoagulant impacts processing
- *Serum tubes should not be used as a discard tube* before coagulation collection. Another citrate (blue top) tube should be used as the discard tub

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3. Serum Separator Tubes (SST) / Gold-Top Serum Separator Tube (SST)

Tube Contents and Usage

- Contains clot activator and serum gel separator (gel separator which separates the cells from the serum for a variety of testing)
- Used for chemistry, serology, and immunology tests
- Not suitable if red-top tubes are specified for a test

Clot Activation and Centrifugation

A. Invert the tube to activate clotting
B. Let stand for 20-30 minutes
C. Centrifuge for 10 minutes

Frozen Serum Preparation with blood donation

A. If frozen serum is required:
    1. Pour serum into a plastic vial
    2. Freeze
B. Caution against freezing Vacutainer® tubes

4. Red-Top Tube, Plastic

- Designed for serum collection for specific lab tests, the liquid portion of blood remaining after it has been allowed to clot. No additives. Centrifuge after collection
- Caution against using gold-top/SST tubes, Gel separator interference with analysis

These tubes are used for serum testing. They do not contain any additives and are typically used for tests that require serum, such as blood chemistry tests and some infectious disease tests.

5***. Red-Top Tube, Glass***

- Description: Plain glass tube without clot activators, anticoagulants, preservatives, or separator material. No additives
- *When to use:*
    - Blood Bank tests

6. Light Green-Top Tube (lithium heparin and plasma gel separator)

Purpose: (PST/PLAST) may refer to several blood tests, including a Protein S Antigen test, a Partial Thromboplastin Time test, and a plasma separation tube

- Collection of heparinized plasma for routine chemistry tests, gel separates the cells from the plasma for a wide range of testing, including chemistries.
    - An *SST tube is an acceptable substitute* for most testing that identifies PST/PLAST as the primary tube.
- Procedure:
    1. Fill the tube with blood.
    2. Immediately invert the tube 8-10 times.
        a. Importance: Proper mixing ensures adequate anticoagulation of the specimen.

7. Dark Green Top Tube for Stat Draws (immediate transport)

- Contains sodium heparin or lithium heparin
- Used for the collection of heparinized plasma or whole blood for special tests, such as Cytogenetics and TB QuantiFERON
- No gel separator also used for ammonia testing
- Note: After filling the tube with blood, immediately invert the tube 8-10 times

Purpose: Mix and ensure adequate anticoagulation of the specimen

- These tubes are used for tests that require plasma, such as ammonia levels and some chemistry tests. Requires immediate transport.

8. Lavender or Purple Top Tube (EDTA):

- These tubes contain the anticoagulant Ethylenediaminetetraacetic acid (EDTA) used for tests that require whole blood or plasma.

- K2 or K3 EDTA is used for most hematology studies, CBC, SED Rate (ESR), and Reticulocyte tests (K2 or K3 test tubes are used for blood studies)
- They are often used for complete blood counts (CBC) and blood bank tests.

9. *Gray Top (Sodium Fluoride/Potassium Oxalate*):

- Contains an anticoagulant and a preservative,
- Used for tests that require glucose and alcohol levels.

10. *Yellow Top Tube (ACD or SPS):*

- Contains anticoagulants: Acid Citrate Dextrose (ACD) or Sodium Polyanethol Sulfonate (SPS), which consists of trisodium citrate, citric acid, and dextrose.
- Used for blood cultures, DNA Studies, HIV Cultures

11. *Black Top tube*

- Used for blood collection and anticoagulant for sedimentation rate (ESR) tests.

12. *Pink Top Tube*:

- K3, EDTA tube used for testing in Blood Bank (blood typing and crossmatching, requires employee ID, date, and time of collection on the tube)

13. *Royal Blue top with purple stripe*

- Metal-free EDTA tube
- Mainly for whole blood heavy metal testing (lead, manganese, chromium, cobalt).

14. ***Pearl Top Tube*** ***(*****Plasma Preparation or PPT).**

- Separating gel and (K2), EDTA.
- Used for testing of Adenovirus PCR, Toxoplasma PCR, HHV-6 PCR, HIV Viral Load PCR

15. Tan Top Tube

- Sodium EDTA for blood lead analysis testing (lead, manganese, chromium, cobalt).
- Used for trace metal whole blood or plasma determinations

16. *Yellow Top Tube* –

- With ACD (or gold top, used for testing for blood bank, DNA and paternity test, whole blood determinations, chemistry, and immunology testing. Therapeutic blood monitoring.
- In therapeutic blood monitoring, *trough levels* should be tested 30 minutes prior to the next dose.

17. *PICO syringe* – Used for blood gas and other whole-blood POC testing. Contains heparin to prevent clotting. ABG are out of the scope of practice for phlebotomy

18. *Research Kits* – Collected after all diagnostic labs have been obtained. Used for research studies.

I. Exceptions to the Order of Draw

- When collecting blood from any VAD which is routinely flushed with heparin, coagulation tubes should be collected via venipuncture. If coagulation testing is collected from a VAD where the line has been heparinized (flushed with heparin), coagulation results may be affected.
- If venipuncture is not possible:
  - Collect the citrate tube (blue top) last, after 20mL of blood has been withdrawn for other testing, or as waste.

- Just before drawing the blue top tube as the last tube, draw 1mL into a discarded blue top tube to prevent cross-contamination from the additive of previously drawn tubes.
  - For pediatric patients, one must consider the maximum allowable draw volume.
  - The above procedure can be followed using a 10mL waste instead of 20mL.
  - Drawing the minimum specimen volume should be the norm for pediatric patients.

Order of Draw for Micro Container Collection Tubes

A. The order of draw for micro container collection tubes differs from that of vacutainer tubes. This procedure follows guidelines set forth by the manufacturer (BD Microtainer® and/or Greiner Bio-One)

B. CLSI guidelines for capillary puncture blood collection require that the order of draw begins with *additive* tubes.

Capillary tubes – Used for whole blood tests and/or point-of-care testing (blood gases).

Blue top – Tube contains sodium Citrate. CANNOT be collected via capillary collection method; tube MUST contain venous blood only.

Lavender – Tube contains K2EDTA additive, used for hematology testing.

- Collected first to obtain adequate volume, minimize platelet clumping, and ensure accurate hematology test results
- Inside walls of the microtainer are sprayed with EDTA. To prevent clotting during the collection process, blood should run freely down inside wall of the container to pick up EDTA.
- Mix by inverting 10 – 15 times immediately after collection. Tube inversions prevent clotting.

Green – Tube contains Lithium Heparin, PST™ Gel additive with or without Amber Coating to protect light-sensitive assays, used for plasma chemistry testing. Mix by inverting 10 – 15 times immediately after collection. Tube inversions prevent clotting.

SST Gold – Tube contains Clot Activator / SST™ Gel separator, used for serum chemistry testing. Mix by inverting 5 – 10 times immediately after collection.

Red–tube contains no additive, used for serum chemistry testing, serology, and blood bank testing. Mix by inverting 5 – 10 times immediately after collection.

Newborn screening card –a small, absorbent card used to collect a blood sample from a newborn baby for screening for certain genetic disorders. See card for instructions

Chapter 13: Standard Order for Drawing Blood

Order of Draw

The order of the draw is based on minimizing the risk of sample contamination by additives from one tube affecting the results of another.

The recommended order of draw:

Blood Culture Tubes:

- These tubes are used for microbiological studies to detect the presence of bacteria or other microorganisms in the blood. Blood culture tubes are always drawn first to minimize the risk of contamination from other additives.

Citrate Tubes:

- Tubes containing citr
- ate are used for coagulation studies, such as PT (prothrombin time) and APTT (activated partial thromboplastin time). Citrate is an anticoagulant that binds calcium, preventing blood clotting.

Serum Tubes (without additives or clot activators):

- These tubes are used for various serum tests, including chemistry panels and certain hormone assays. Serum tubes without additives or clot activators allow blood to clot, and the serum is then separated by centrifugation.

Heparin Tubes:

- Heparin is an anticoagulant used in tubes for plasma testing, such as electrolytes and certain enzyme assays. Heparin prevents blood clotting by inhibiting thrombin formation.

EDTA Tubes:

- *EDTA (Ethylenediaminetetraacetic acid)* is an anticoagulant used for complete blood counts (CBC) and blood cell morphology (form and structure) examinations. EDTA prevents blood clotting by chelating (bonding) calcium.

Oxalate/Fluoride Tubes:

- Tubes with oxalate/fluoride are used for glucose testing. Oxalate and fluoride act as antiglycolytic agents, inhibiting glycolysis and preserving glucose levels.

Other Specialized Tubes:

- Tubes with additives or preservatives for specialized tests may follow, depending on the laboratory's requirements.
- Examples include tubes for specific hormones, enzymes, or nucleic acid testing.
- Additionally, individual laboratory protocols may dictate variations based on the types of tests being performed.
- Healthcare professionals should always follow the specific guidelines provided by their institution or laboratory to ensure proper blood collection and accurate test results.
- Adhering to the recommended order of draw helps minimize the risk of sample contamination and ensures the reliability of sample.

Prepping for a Blood Collection

Skin Preparation

- Locate the vein, and scrub the venipuncture site with 70% alcohol for a minimum of 30 seconds.
- Apply iodine solution (1-2% tincture of iodine) for 30 seconds in circles away from the puncture site, covering a circular area 1 to 2 inches in diameter.
- If the patient is allergic to iodine, cleanse the area with alcohol for 60 seconds

Bottle Preparation

- Inspect the bottle surface, the media, and the sensor.

- Ensure that the broth is clear, the sensor is intact, and a blue-green color.
- Do not use a bottle if the sensor is yellow, the media is cloudy, or if the bottle is cracked or dropped.
- Remove the protective flip-top over the cap
- Cleanse the rubber stopper with 70% alcohol or iodine solution.
- Allow to dry for 1 minute before adding blood to the bottle.

Complete blood draw from the patient

- Add 10 ml blood to the aerobic bottle first, using a syringe, then the anaerobic second
- Do not add air to the anaerobic bottle

Direct Draw with Butterfly: (Video)

- Use the BacT/Alert Adapter Cap (insert, if needed for other blood collection tubes).
- Connect the Adapter Cap to the luer connector of the butterfly collection set.

Performing venipuncture

- When the needle is in the vein, secure it with tape or hold it in place. ·
- Place the Adapter Cap on the aerobic BacT/Alert culture bottle rubber stopper and press down to penetrate and obtain blood flow.
- Make sure to hold the Adapter Cap down on the bottle.
- After obtaining the specified amount of blood, move the Adapter Cap from the aerobic bottle to the anaerobic bottle and continue the collection.
- If additional blood is required for other tests, place the Adapter Insert into the Adapter Cap and snap it into place. This makes the cap compatible with vacuum collection tubes.
- After blood collection is complete, remove the Adapter Cap from the culture bottle and then remove the needle from the patient's vein

Chapter 14: Venipuncture Procedures & Complications

Collecting blood, whether for diagnostic testing, blood donation, or other medical purposes, involves potential complications and considerations that healthcare professionals must be aware of to ensure the safety and well-being of the patient.

Identifying the patient

This is the most important step in venipuncture.

The phlebotomist must ask the patient's name; do not ask if the patient is named John Doe. Instead, elicit the name as a question and wait for the verbal response.

In an outpatient setting, such as a lab, a patient should provide additional information such as his or her birthdate.

A patient should fast—avoiding all but water—for 8 to 12 hours before a blood test.

If you arrive to draw a fasting specimen just as the patient finishes breakfast, it is best to notify the care provider immediately. This means you may need to either reschedule the test or, depending on the test and the physician, perform an alternative

Inspecting and Palpating the Vein

Choosing a suitable vein is a critical step in the blood drawing process, and it plays a crucial role in the success of the venipuncture procedure. Consuming food or beverages may interfere with the results of a blood test.

Veins commonly used for venipuncture

- Cephalic vein
- Basilic vein
- Antecubital fossa
- Median Cubital (H formation)
- Dorsel vein

Importance of selecting the right veins during venipuncture

Efficiency and Success of Blood Collection

- Choosing a suitable vein increases the efficiency of the blood collection process.
- A well-selected vein is more likely to yield a successful blood draw on the first attempt, minimizing patient discomfort and the need for multiple needle insertions.

Reducing Patient Discomfort

- Selecting an appropriate vein helps minimize patient discomfort during the blood draw.

- The presence of easily accessible and visible veins allows for a smoother insertion of the needle, reducing pain and anxiety associated with the procedure.

Avoidance of Hematomas and Complications

- Choosing a suitable vein reduces the risk of complications such as hematomas (blood clots), bruising, and tissue damage.
- Proper vein selection ensures that the needle is inserted accurately, minimizing the potential for adverse effects and improving patient safety.
- When selecting a venipuncture site, phlebotomists should avoid *tortuous veins* because they are abnormally crooked, curving, angulated/kinking, looping, and/or spiral twisting. They produce longer distances without connecting to sublingual capillaries. impair blood flow, negatively affecting test results.
- Venipuncture *shouldn't be performed* on a hematoma, even a very small one. When you have no other choice, the venipuncture should be made distal (below) the hematoma

Tortuous veins Are twisted, dilated, and elongated veins that have lost their normal shape. They can affect both arteries and veins.

Optimizing Blood Flow

A suitable vein ensures optimal blood flow during the collection process.

A vein with good integrity and proper size allows for the efficient retrieval of an adequate volume of blood, reducing the time required for the procedure and the risk of clotting.

Minimizing the Need for Tourniquet Application

- When a suitable vein is chosen, the need for prolonged tourniquet application may be reduced.
- Proper vein selection enhances vein distension, allowing for successful blood collection without extended periods of tourniquet use, which could cause patient discomfort.

Adaptation to Patient Characteristics

- Different patients have unique vein characteristics based on factors such as age, health status, and previous medical interventions.
- Healthcare providers must adapt their approach, taking into consideration individual patient factors to choose a suitable vein for blood collection.

Avoiding Complications in Vulnerable Populations

- Vulnerable populations, such as pediatric or elderly patients, may have veins that are more fragile or difficult to access.
- Selecting an appropriate vein with consideration of the patient's age and health status helps prevent complications in these populations.

Enhancing Patient Cooperation

- A successful and efficient blood draw contributes to positive patient experiences and enhances patient cooperation during the procedure.
- When patients perceive that healthcare providers are skilled in vein selection, they may feel more confident and at ease.

Addressing Previous Venipuncture Challenges

- Patients with a history of difficult venous access or multiple venipuncture attempts may require special attention to vein selection.
- Healthcare providers should consider past challenges to choose a suitable vein and improve the chances of a successful blood draw.

Ensuring Sample Quality for Laboratory Testing

- Choosing an appropriate vein contributes to obtaining high-quality blood samples for laboratory testing.
- The proper collection of a well-mixed blood specimen from a suitable vein ensures the accuracy and reliability of diagnostic test results.

Applying Tourniquet

- Applying a tourniquet properly is crucial during venipuncture, and it serves several important purposes in the blood collection process.
- Here are the key reasons why applying a tourniquet properly is important

Facilitating Vein Distension

- The primary purpose of a tourniquet is to create vein distension, making it easier for healthcare providers to locate and access the vein for blood collection.
- Proper application increases the visibility and palpability of veins, aiding in successful venipuncture.

Enhancing Blood Flow

- When applied correctly, a tourniquet temporarily restricts venous blood flow, causing veins to expand.
- This enhanced blood flow facilitates the collection of an adequate volume of blood for diagnostic testing, reducing the likelihood of multiple needle insertion attempts.

Reducing Puncture Attempts

- Proper application of a tourniquet increases the chances of a successful blood draw on the first attempt.
- By improving vein visibility and distension, healthcare providers can more accurately insert the needle, minimizing the risk of multiple puncture attempts and associate patient discomfort.

Minimizing Patient Discomfort

- A tourniquet, when applied properly, helps minimize patient discomfort during the blood collection process.
- By efficiently distending the veins, healthcare providers can reduce the time the tourniquet needs to remain in place, improving overall patient experience.

Preventing Tissue Contamination

- The application of a tourniquet ensures that blood is collected directly from the vein rather than including tissue fluids.
- This helps prevent contamination of the blood sample with interstitial fluids, ensuring the accuracy of laboratory test results.

Standardizing Blood Collection Procedures

- Proper tourniquet application is part of standardizing blood collection procedures.
- Following consistent practices helps maintain accuracy and reliability in the blood collection process, contributing to the quality of healthcare services.

Timing Considerations

- The tourniquet should be applied for an appropriate duration (no more than 1 min) to achieve optimal vein distension without causing complications.
- Timing considerations are crucial to balancing the need for vein visibility and minimizing potential adverse effects, such as hemoconcentration (high hematocrit level).

Hemoconcentration

- means a concentration of blood. If the tourniquet is left on too long, the higher concentration—or thickening—of the blood. This may not properly reflect a patient's true health. Certain analytes affected are Albumin, Cholesterol, Bilirubin, Triglycerides, and more.

- If a vein survey takes too long, release the tourniquet for at least 2 minutes before re-establishing it for puncture.

Consideration of Patient Factors

- Different patients may require variations in tourniquet application based on factors such as age, medical history, and individual vein characteristics. Healthcare providers should adapt their approach to the unique needs of each patient.

Patient Safety

- Proper tourniquet application contributes to overall patient safety during venipuncture.
- Careful consideration of factors such as tourniquet placement and duration helps prevent complications and ensures a safe blood collection procedure.

Preventing Tourniquet-Related Complications

- Incorrect tourniquet application can lead to complications, such as tissue damage, nerve compression, or excessive hemoconcentration.
- Proper application reduces the risk of these complications, promoting the safety of the blood collection process.
- -The tourniquet application requires a placement 3–4 inches (7.6 to 10.2 cm) above the venipuncture site. The tourniquet should be tied loose enough so that it does not impede arterial blood flow but tight enough to slow venous blood flow.

Inserting the Needle

The phlebotomist should ask for assistance from another phlebotomist to draw the specimen if needed.

Inserting a needle into a venipuncture site involves several potential complications and considerations that healthcare providers must be aware of to ensure patient safety and the success of the procedure.

Potential complications and special circumstances associated with inserting a needle during venipuncture:

If attempting a hemoglobin blood draw on a patient in intensive care, and an IV is already in the left arm. Additionally, there's no suitable antecubital vein or hand vein in the right arm, A finger prick can be performed to check the oxygen-carrying range of the blood (hemoglobin).

- *Pain and Discomfort*: Patients may experience pain or discomfort during needle insertion.
    - This is particularly relevant for individuals with a fear of needles, and healthcare providers should use techniques to minimize pain, such as using a smaller gauge needle or applying a topical anesthetic.
- *Vasovagal Response*: Some individuals may have a vasovagal response (lowers blood pressure and heart rate when triggered by stress, pain, or other factors), which can result in fainting, dizziness, or nausea.
    - This response can be triggered by anxiety or the sight of blood. Healthcare providers should be prepared to manage these reactions and ensure the patient's safety.
    - Anticipatory fear of pain, especially in children, may cause a vasovagal reaction (VVR), where heart rate and blood pressure increase, resembling a "fight-or-flight" response. A phlebotomist can tell the child there's no need to be frightened of a needle.
    - Sampling blood from children can be a difficult task. The phlebotomist might feel inclined to assure a child that the test won't hurt. This is not a best practice or a good strategy. To comfort children and lower their stress, CLSI advises the phlebotomist to:
        - Make an introduction to build rapport and lessen anxiety
        - Allow patient participation
        - Allow parents to hold children when possible
        - Use an assistant
- *Difficult Vein Access*: Difficulties in locating and accessing veins can arise due to factors such as obesity, dehydration, or vein visibility.

    - Special techniques, such as using a smaller gauge needle, a warm compress, or a vein finder device, may be necessary to improve vein visibility and facilitate successful needle insertion.
    - The phlebotomist can ask a patient to make a fist before venipuncture, and may even ask a patient to hold the first during the procedure.
    - The fist helps make veins more visible. However, the patient should never be allowed to pump their fist because fist-pumping can and does skew the results.
    - If a fist does not seem to help make veins more visible, an alternative is to warm the site with a towel.
        - A second alternative is to ask the patient to lower their arm to increase blood flow.
- *Hematoma Formation*: Improper needle insertion or inadequate pressure applied after withdrawing the needle can lead to hematoma formation—localized bleeding and blood clotting under the skin.
    - Careful technique and proper compression can help minimize the risk of hematoma.
- *Infiltration of Medications*: If a medication is being administered through the venipuncture site, inadvertent infiltration (leakage of the medication into surrounding tissues) can occur.
    - This can cause tissue damage and affect the intended therapeutic effect of the medication.
- *Nerve Injury*: Improper needle insertion may lead to nerve injury, resulting in pain, numbness, or tingling.
    - Healthcare providers should be knowledgeable about the anatomy of the area and exercise caution to avoid nerve damage.
- *Infection Risk*: Any breach of skin integrity during needle insertion increases the risk of infection.
    - Strict adherence to aseptic techniques, including proper hand hygiene and the use of sterile equipment, is crucial to minimize infection risk.
- Allergic Reactions: Patients may be allergic to materials used in the needle, such as latex or certain metals.
    - Healthcare providers should be aware of patients' allergies and use alternative materials when necessary.
- *Complications in Special Populations*: Certain patient populations, such as those with bleeding disorders, may be more prone to bleeding complications.

    - Special care and consideration are required when performing venipuncture in these individuals.
- *Use of Blood Thinners*: Patients taking anticoagulant medications or blood thinners may be at an increased risk of bleeding during and after needle insertion.
    - Healthcare providers should take precautions to minimize bleeding and closely monitor patients on these medications.

Tube inversions are 180-degree up/down rotations and are necessary to mix the blood specimen with each tube's additive.

Securing the Puncture Site

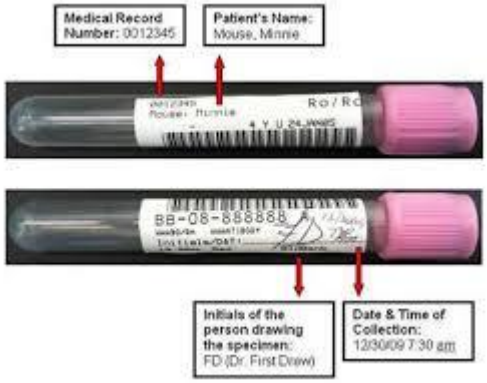
Securing the puncture site after venipuncture is a crucial step in the process to prevent complications and ensure patient comfort.

Potential complications and special circumstances associated with securing the puncture site during venipuncture:

- *Hematoma Formation*: Hematoma, a localized collection of blood under the skin, can occur if the puncture site is not adequately secured.
    - Applying firm, direct pressure over the site for a sufficient amount of time helps prevent hematoma formation.
- *Excessive Bleeding*: Inadequate pressure or premature removal of pressure after venipuncture can lead to excessive bleeding.

    - It is essential to monitor the site and ensure that bleeding is adequately controlled before releasing pressure.
    - If bleeding still continues, apply a pressure bandage and have the patient elevate the site. The pressure bandage encourages blood clotting, but does not constrict normal blood circulation.
    - Do not leave the patient until complete bleeding stoppage occurs.
- *Bruising:* Improper securing of the puncture site may lead to bruising, particularly in individuals with fragile or easily bruised skin.
    - Gentle handling and proper pressure application can minimize the risk of bruising.
- *Infection Risk*: The puncture site is vulnerable to infection until the skin is properly sealed.
    - Healthcare providers should ensure the cleanliness of the site and apply an appropriate dressing to minimize infection risk.
- *Allergic Reactions*: Some individuals may be allergic to materials used in dressings, adhesive tapes, or other securing devices.
    - Healthcare providers should be aware of any known allergies and choose alternative materials if necessary.
- *Patient Comfort:* Patients may experience discomfort or pain at the puncture site after venipuncture.
    - Proper securing techniques, including the use of comfortable and non-restrictive dressings, can enhance patient comfort.
- *Compromised Circulation*: In certain circumstances, such as when securing the puncture site too tightly, there may be a risk of compromising blood circulation to the extremity.
    - Healthcare providers should ensure that dressings are applied snugly but not excessively tight.
- *Special Populations*: Pediatric patients, elderly individuals, or those with fragile skin may require special considerations when securing the puncture site.
    - The choice of materials and the application technique may need to be adapted to the specific needs of these populations.
- *Use of Anticoagulants*: Patients on anticoagulant medications may be at an increased risk of bleeding and bruising.
    - Healthcare providers should be cautious when securing the puncture site in these individuals and monitor for signs of bleeding.

- *Patient Education*: Providing clear instructions to the patient regarding care for the puncture site after venipuncture is essential.
    - Patients should be informed about signs of complications (such as increasing pain or swelling) and encouraged to report any concerns promptly.
- *Monitoring for Complications*: Healthcare providers should continue to monitor the puncture site after securing it to detect any signs of complications, such as bleeding, infection, or allergic reactions.
    - Following established protocols, individualizing care based on patient needs, and staying informed about the latest best practices contribute to successful and complication-free post-venipuncture care.



Labeling the Blood Collection Tubes & Requisition

When collecting a patient's specimen(s) in the laboratory for the patient's healthcare provider, the phlebotomist finds guidance from an ordering physician's test requisition.

The ordering physician's test requisition fully identifies patient information, prescriber information, test types/codes, additional test requests, etc.

Labeling blood collection tubes is a crucial step in the venipuncture process that helps ensure the accurate identification of patient samples.

Failing to properly label tubes can lead to serious complications and jeopardize patient safety.

Potential complications and special circumstances associated with labeling blood collection tubes:

- *Patient Misidentification*: Incorrectly labeled tubes can result in patient misidentification.
    - This can lead to inaccurate test results, inappropriate treatment, and compromised patient safety.
    - Healthcare providers must use a reliable patient identification system and verify patient information before labeling tubes.
- *Specimen Mix-up*: Labeling errors may lead to the mixing up of specimens from different patients.
    - This can result in misdiagnoses, inappropriate treatments, and compromised patient care.
    - Adherence to strict labeling protocols is essential to prevent specimen mix-ups.
- *Delayed or Incorrect Treatment*: Inaccurate labeling can lead to delayed or incorrect treatment decisions based on incorrect laboratory results.
    - This poses a significant risk to patient health, especially in emergency or critical care situations.
- *Legal and Ethical Implications*: Incorrectly labeled samples may have legal and ethical implications for healthcare providers and institutions.
    - Patient confidentiality and the accuracy of medical records are critical components of healthcare compliance.
- *Laboratory Errors:* Mislabeling can lead to errors in the laboratory, affecting the accuracy and reliability of test results.
    - This compromises the quality of patient care and may necessitate repeat testing, leading to additional stress for the patient.
- *Patient Anxiety and Discomfort*: Patients may experience anxiety and discomfort if they are aware of potential labeling errors.
    - Clear communication and reassurance about the importance of accurate labeling can help mitigate patient concerns.
- *Special Circumstances in Pediatric Patients*: Pediatric patients, particularly infants and young children, may have unique challenges in terms of labeling due to their inability to provide accurate information.
    - Careful verification and cross-checking with parents or guardians are essential in these cases.

- *Language Barriers*: Patients with limited proficiency in the local language may face challenges in providing accurate information for labeling.
    - Healthcare providers should use appropriate translation services or multilingual staff to ensure accurate labeling in such cases.
- Unconscious or Unresponsive Patients: In situations where patients are unconscious or unresponsive, healthcare providers must rely on available identification methods, such as identification bands, to ensure accurate labeling.
    - Special attention is needed to prevent mislabeling in these circumstances.
- Critical Care and Time Sensitivity: In critical care situations, where time is of the essence, accurate and swift labeling becomes even more critical.
    - Healthcare providers must balance the urgency of sample collection with the need for accurate labeling.
- Use of Barcode Technology: Implementing barcode technology for labeling can enhance accuracy and efficiency.
    - However, healthcare providers should be trained in the proper use of this technology to avoid potential errors associated with scanning and labeling.

Potential complications and special circumstances associated with blood collection:

- *Pain and Discomfort*: The blood collection process may cause pain and discomfort for the patient. This can be influenced by factors such as the needle size, technique used, and individual pain tolerance. Healthcare providers should prioritize minimizing patient discomfort.
- *Syncope (Fainting)*: Some individuals may experience syncope (fainting) during or after blood collection due to anxiety, fear of needles, or other factors. Proper positioning, monitoring, and addressing patient anxiety can help prevent syncope.
- *Hematoma Formation*: Inadequate pressure applied after needle removal or accidental needle movement during blood collection can lead to the formation of a hematoma—a localized collection of blood under the skin. Proper technique and post-collection care can minimize the risk of hematoma.

**The most common complication in phlebotomy is hematoma: blood accumulation around the tissue. Other less common complications are needle overpenetration (going through the vein), phlebitis due to repeated venipuncture, and hemoconcentration.

(Hematoma after blood draw)

- *Excessive Bleeding*: Individuals with bleeding disorders or those taking anticoagulant medications may be at an increased risk of excessive bleeding during blood collection.
    - Healthcare providers should take precautions, such as applying pressure and using appropriate-sized needles, to minimize bleeding.
- *Infection Risk:* Any breach of skin integrity during blood collection increases the risk of infection.
    - Strict adherence to aseptic techniques, including hand hygiene and the use of sterile equipment, is essential to prevent infections.
- *Allergic Reactions*: Some patients may be allergic to materials used in blood collection, such as latex or adhesive components of bandages.
    - Healthcare providers should be aware of patients' allergies and use alternative materials when necessary.
- Vessel Damage: Improper technique or multiple attempts at venipuncture can lead to vessel damage, increasing the risk of complications such as *phlebitis* (inflammation of a vein) or *thrombosis* (formation of blood clots).
    - (Phlebitis related to chemo)

-  (Thrombosis in the arm)
- 

- *Nerve Injury*: Nerve injury can occur during blood collection, particularly if the needle is inserted too deeply or if there are anatomical variations. Healthcare providers should be cautious to avoid nerve damage.
- *Complications in Special Populations*: Certain populations, such as pediatric patients, elderly individuals, or those with fragile veins, may require special considerations during blood collection. Adjustments in technique, equipment, or communication may be necessary.
- *Contamination of Blood Samples*: Contamination of blood samples can lead to inaccurate test results. Proper collection techniques, including using the appropriate tubes and additives, are crucial to ensure the reliability of laboratory tests.
- *Patient Anxiety and Psychological Impact*: Some individuals may experience significant anxiety or fear associated with blood collection. Effective communication, empathy, and distraction techniques can help alleviate patient anxiety and improve the overall experience.

Regular updates on best practices and ongoing education are essential to maintaining high standards in blood collection procedures.

Chapter 15: Other Forms of Blood Collection

Dermal Puncture

Principles of Dermal Puncture

- *Dermal puncture*, also known as *capillary puncture or fingerstick*, is a medical procedure involving the collection of blood from the capillaries located just beneath the skin's surface.
- It is a less invasive method compared to traditional venipuncture, which involves drawing blood from a vein.

Dermal puncture is a suitable method for blood collection in specific situations, but there are also cases where it may not be the most appropriate choice.

Acceptable circumstances when dermal puncture is suitable or not

1. Suitable for Dermal Puncture
    a. Infants and Young Children
    b. Point-of-Care Testing
    c. Limited Blood Volume
    d. Routine Screening in Newborns
    e. Access to Veins is Difficult
    f. Monitoring Blood Glucose Levels
2. Not Suitable for Dermal Puncture
    a. Large Blood Volume Requirements
    b. Specialized Testing
    c. Vulnerable Vein Sites
    d. Patients on Anticoagulants
    e. Certain Age Groups

The suitability of dermal puncture depends on factors such as *the patient's age, the required blood volume, the specific tests being performed, and the patient's overall health.*

Healthcare providers need to carefully assess each situation to determine the most appropriate method for blood collection.

Dermal Puncture Supplies

Lancet or Blood Lancet Device

- Lancets are small, disposable devices with a sharp needle used to puncture the skin and create a small incision for blood collection.
- Some lancets come as part of a blood lancet device, which helps control the depth of the puncture.

Alcohol Swabs or Antiseptic Wipes

- Alcohol swabs or antiseptic wipes are used to clean the puncture site before blood collection to reduce the risk of infection.

Sterile Gauze or Cotton Balls

- Sterile gauze or cotton balls are used to apply gentle pressure to the puncture site after blood collection to minimize bleeding and reduce the risk of hematoma formation.

Bandages or Adhesive Strips

- Bandages or adhesive strips are used to cover the puncture site after blood collection to protect it and help stop bleeding.

Microcontainers or Capillary Tubes

- Microcontainers or capillary tubes are small tubes used to collect and transport small amounts of blood from the puncture site to the laboratory for testing.

Micro collection Tubes

- These are small plastic or glass tubes with a colored cap designed to collect and store capillary blood. The color of the cap often corresponds to the type of additive in the tube for specific laboratory tests.

Tourniquet

- A tourniquet is used to temporarily impede blood flow to the puncture site, making veins more visible and aiding in the blood collection process.

Disposable Gloves

- Healthcare providers should wear disposable gloves to maintain aseptic conditions during the procedure and to protect against potential exposure to bloodborne pathogens.

Sterile Disposable Towels or Chux Pads

- These disposable towels or chux pads are used to create a clean and comfortable workspace for the patient during the blood collection procedure.

Biohazard Waste Container

- A designated container for the safe disposal of used lancets, gauze, gloves, and other potentially contaminated materials to adhere to proper infection control practices.

Patient Identification Labels

- Labels with patient identification information, such as name and date of birth, to ensure proper identification of collected blood samples.

Sharp Container

- A container specifically designed for the disposal of used lancets and other sharp objects to minimize the risk of needlestick injuries.

It's important for healthcare providers to follow standard protocols and guidelines for dermal puncture, including the proper use and disposal of supplies. Additionally, the specific supplies used may vary based on the purpose of blood collection and the tests being performed.

Dermal Puncture Procedure

The dermal puncture procedure, also known as capillary puncture or fingerstick, is a method of collecting small amounts of blood from the capillaries just beneath the skin's surface.

It is commonly used in situations where a smaller blood volume is sufficient for diagnostic testing.

Overview of the Dermal puncture procedure:

1. Gather Necessary Supplies
    a. Ensure that all necessary supplies are assembled, including lancets, alcohol swabs, sterile gauze or cotton balls, bandages, microcontainers or capillary tubes, tourniquet, disposable gloves, and patient identification labels.
2. *Prepare the Patient*
    a. Explain the procedure to the patient, ensuring they understand what to expect.
    b. Obtain informed consent if required.

c. Position the patient comfortably, considering factors such as age and the chosen puncture site.

3. *Select the Puncture Site*
   a. Common puncture sites include the fleshy part of the fingertip, the heel (especially in newborns), or other areas with a sufficient capillary bed.
   b. Choose a site that is clean, well-vascularized, and free from visible lesions or scars.
   c. The World Health Organization explains that vigorous massaging or squeezing dilutes the specimen with tissue fluid (plasma), which increases the probability of hemolysis.
   d. 

4. *Clean the Puncture Site*
   a. Use an alcohol swab or antiseptic wipe to clean the puncture site thoroughly.
   b. Allow the site to air-dry briefly or use sterile gauze to pat it dry.
5. *Warm the Puncture Site*
   a. If needed, warm the puncture site slightly to enhance blood flow. This can be done by gently massaging or applying a warm compress for a short duration.
6. *Apply a Tourniquet*
   a. Apply a tourniquet above the chosen puncture site to temporarily impede blood flow, making the capillaries more visible.
7. *Puncture the Skin*
   a. Use a lancet to puncture the skin at the selected site.
   b. For some devices, follow the manufacturer's instructions to control the depth of the puncture.
   c. Ensure a quick, smooth, and controlled puncture.
8. Collect Blood
   a. Allow blood to flow naturally into microcontainers or capillary tubes.

b. Microcontainers may have a built-in plunger to facilitate blood collection.
c. Ensure the container is filled with the required volume of blood.

9. *Release the Tourniquet*
    a. Release the tourniquet before removing the lancet to allow blood flow to return to normal.
10. *Remove the Lancet*
    a. Remove the lancet from the puncture site.
11. *Apply Pressure and Dress the Puncture Site*
    a. Use sterile gauze or cotton to apply gentle pressure to the puncture site.
    b. If needed, cover the site with a bandage or adhesive strip.
    c. Ensure hemostasis to minimize bleeding and reduce the risk of hematoma formation.
12. *Label the Specimen*
    a. Label the collected blood specimen with patient identification information.
    b. Attach any necessary labels or requisition forms.
13. *Dispose of Waste*
    a. Discard used lancets and any other disposable items in designated biohazard and sharps containers.
14. *Provide Patient Instructions*
    a. Instruct the patient on post-procedure care, including any restrictions or activities to avoid.
    b. Provide information on when and how to remove the dressing.
15. *Document the Procedure*
    a. Record details of the dermal puncture procedure in the patient's medical record, including the date, time, site, and any relevant observations.

Healthcare providers must adhere to established protocols, maintain aseptic techniques, and consider individual patient needs during the dermal puncture procedure.

Regular training and ongoing education can contribute to maintaining proficiency and ensuring the quality and safety of blood collection practices.

Newborn Screening

Inborn errors of metabolism (IEMs) are a group of rare genetic disorders characterized by the body's inability to properly process certain substances, leading to the accumulation of harmful substances or deficiencies of essential compounds.

Newborn screening and diagnostic testing are crucial for early detection and intervention in individuals with inborn errors of metabolism.

Tests commonly used for detecting and diagnosing inborn errors:

- *Newborn Screening (NBS):*
    - *Phenylketonuria (PKU):* Measures phenylalanine levels in the blood.
    - *Congenital Hypothyroidism (CH):* Measures thyroid-stimulating hormone (TSH) and thyroxine (T4) levels.
    - *Galactosemia:* Screens for elevated levels of galactose or its metabolites.
    - Maple Syrup Urine Disease (MSUD): Measures levels of amino acids in the blood, including leucine, isoleucine, and valine.
    - *Homocystinuria*: Measures methionine levels.
    - Sickle Cell Disease and other Hemoglobinopathies: Identifies abnormal hemoglobin variants.
- *Urine Organic Acid Analysis:*
    - Detects abnormal levels of organic acids excreted in urine.
    - Helps identify disorders such as organic acidemias, including methylmalonic aciduria and propionic acidemia.
- *Blood Amino Acid Analysis:*
    - Measures the levels of amino acids in the blood.
    - Useful for identifying disorders like phenylketonuria (PKU), maple syrup urine disease (MSUD), and amino acid metabolism disorders.
- *Enzyme Assays:*
    - Direct measurement of specific enzyme activities to identify enzyme deficiencies.
    - Examples include enzyme assays for disorders like Pompe disease, Gaucher disease, and Fabry disease.
- *Genetic Testing:*
    - DNA Sequencing: Identifies mutations in specific genes associated with inborn errors.

    - Next-Generation Sequencing (NGS): Allows simultaneous analysis of multiple genes, facilitating the identification of various genetic disorders.
    - Chromosomal Microarray (CMA): Detects chromosomal abnormalities associated with certain metabolic disorders.
- *Plasma Acylcarnitine Profile*:
    - Measures levels of acylcarnitines in blood.
    - Useful for identifying disorders of fatty acid oxidation.
- *Amniotic Fluid Analysis*:
    - Performed during pregnancy to detect certain metabolic disorders in the developing fetus.
    - May include testing for enzyme activity, amino acids, and other markers.
- *Cerebral Spinal Fluid (CSF) Analysis*:
    - Used in cases where neurological symptoms are present.
    - Helps identify certain metabolic disorders affecting the central nervous system.
- *Biomarker Measurement*:
    - Quantification of specific biomarkers associated with certain metabolic pathways.
    - Example: Measurement of guanidinoacetate in the urine for the diagnosis of guanidinoacetate methyltransferase deficiency (GAMT deficiency).
- *Functional Assays:*
    - Assess the functional activity of specific enzymes involved in metabolic pathways.
    - Used for disorders like lysosomal storage diseases.

The choice of tests depends on the suspected metabolic disorder and the clinical presentation of the individual.

Newborn Screen Procedure

Newborn screening (NBS) is a public health program designed to identify newborns at risk for certain genetic, metabolic, and congenital disorders early in life.

The goal is to detect and intervene before symptoms develop, preventing serious health issues and allowing for timely treatment.

Overview of Newborn Screening

- *Timing of Screening:*
    - Newborn screening is usually conducted within the first 24 to 48 hours of a baby's life. In some cases, additional screens may be performed a few days later.
- *Informed Consent:*
    - Newborn screening is generally considered a routine and standard procedure in many countries.
    - Informed consent is usually not required, but healthcare providers inform parents about the purpose and importance of the screening.
- *Blood Collection:*
    - A small blood sample is obtained from the newborn, typically by pricking the baby's heel. This procedure is commonly known as a heel stick or heel prick.
    - The blood is collected on a filter paper or a special absorbent card, which is then allowed to dry.
- *World Health Organization (WHO)*
    - Guidelines specifically caution against using povidone-iodine when preparing the skin in pediatric and neonatal patients. Instead, the phlebotomist must use alcohol or a cleaning solution per the unit’s policy.
    - -WHO guidelines recommend that an infant heel-prick depth does not go beyond 2.4mm.
- *Bloodspot Drying and Storage:*
    - The bloodspot card is left to dry thoroughly before it is sent to the screening laboratory. Proper drying is essential to prevent contamination and ensure accurate test results.
    - The dried bloodspot card is then stored until it is ready for analysis.
- *Laboratory Analysis:*
    - The dried bloodspot card is sent to a designated laboratory for analysis.

    - The laboratory uses various testing methods, such as tandem mass spectrometry, to measure the levels of specific markers in the blood.
- *Screening for Specific Disorders*:
    - The screening panel includes tests for various inborn errors of metabolism, such as phenylketonuria (PKU), congenital hypothyroidism, galactosemia, maple syrup urine disease (MSUD), and others.
    - Each disorder has specific markers or metabolites that are measured to identify abnormal levels.
- *Results Notification*:
    - Once the screening is complete, the results are communicated to the healthcare provider and parents.
    - In cases where initial results suggest a potential issue, further confirmatory testing is often recommended.
- *Follow-up Testing and Diagnosis*:
    - If a positive result is obtained from the initial screening, confirmatory testing is conducted to establish a definitive diagnosis.
    - Genetic testing and additional diagnostic procedures may be performed to confirm the presence of a specific inborn error of metabolism.
- *Early Intervention and Treatment:*
    - Early detection allows for prompt intervention and treatment. For many inborn errors, dietary modifications, medications, or other interventions can be initiated early, minimizing the impact of the disorder on the child's health.
- *Genetic Counseling*:
    - Families of infants diagnosed with an *inborn error of metabolism* may be referred to genetic counselors who provide information about the nature of the condition, inheritance patterns, and potential implications for future pregnancies.

It's important to note that the specific disorders included in newborn screening panels may *vary by region, country, or healthcare system*.

The overall goal is to identify and manage these conditions early, offering affected infants the best possible outcomes through timely intervention and treatment.

Point-of-Care Testing (Waived Tests)

Strip device

Point-of-care testing (POCT)

POCT refers to medical diagnostic testing performed outside of a traditional laboratory setting, typically at or near the location where the patient is receiving care.

This decentralized approach allows for rapid and convenient testing, with results available quickly, often within minutes.

Point-of-care testing is widely used in various healthcare settings, including hospitals, clinics, physicians' offices, ambulances, and even home care environments.

The manufacturing instructions for point-of-care testing (POCT) devices provide detailed guidance on the proper use, handling, and maintenance of the testing equipment.

These instructions are crucial for ensuring accurate and reliable results, as well as for maintaining the safety of both users and patients.

While the specific instructions may vary depending on the manufacturer and the type of POCT device, here are some common elements found in manufacturing instructions: device description, contraindications, storage requirements, operating instructions, and quality control procedures.

The point-of-care testing (POCT) procedure may vary depending on the specific test being conducted and the type of POCT device used.

Key features of point-of-care testing include:

- *Rapid Results*
    - One of the primary advantages of POCT is the ability to provide quick results, allowing healthcare providers to make immediate decisions about patient care.
- *Convenience*
    - POCT is performed at or near the patient's location, eliminating the need to send samples to a central laboratory and wait for results. This is particularly beneficial in emergencies, critical care settings, or locations where access to a centralized lab is limited.
- *Accessibility*
    - POCT can be easily implemented in various healthcare settings, including remote or resource-limited areas.
    - It enhances access to diagnostic testing and facilitates timely decision-making.
- *Wide Range of Tests*
    - Many different types of tests can be performed using point-of-care devices, including blood glucose monitoring, coagulation testing, infectious disease testing, cardiac markers, pregnancy testing, and more.
- *Portable Devices*
    - Point-of-care testing devices are often compact, portable, and user-friendly.
    - This makes them suitable for use in different healthcare settings and allows for flexibility in testing locations.
- *Reduced Turnaround Time*
    - By eliminating the need for sample transportation to a central laboratory, point-of-care testing significantly reduces turnaround time, enabling faster initiation of treatment or intervention.
- *Patient-Centered Care*
    - POCT contributes to a more patient-centered approach by providing real-time information during the patient encounter. This facilitates

immediate discussions between healthcare providers and patients about treatment options, adjustments, or next steps.

- *Monitoring Chronic Conditions*
    - Point-of-care testing is often used for monitoring chronic conditions, such as diabetes, where patients can perform tests like blood glucose monitoring at home or in a clinic to manage their health.
- *Quality Control*
    - Quality control measures are typically integrated into point-of-care testing devices to ensure accurate and reliable results. However, proper training and adherence to quality assurance protocols are essential for maintaining the reliability of POCT results.

POCT Pre-Test Preparation

- Ensure that the POCT device is in good working condition and has been properly calibrated if required.
- Check the expiration date of any test strips, reagents, or other consumables.
- Confirm that the testing area is clean, well-lit, and properly equipped with necessary supplies.

Patient Identification

- Verify the patient's identity using at least two unique identifiers, such as name and date of birth.
- Provide the patient with information about the test to be performed, including its purpose, potential risks, and expected outcomes.
- Obtain informed consent from the patient, explaining the nature of the test, potential results, and any associated risks.

Collection of Specimen

- Collect the necessary specimen (blood, urine, etc.) following established protocols and using appropriate aseptic techniques.
- For blood collection, perform venipuncture or capillary puncture based on the type of test and the patient's condition.

Application to Test Device

- Apply the specimen to the POCT device according to the manufacturer's instructions. This may involve placing a sample on a test strip, inserting it into the device, or using other specific methods.

Test Processing

- Allow the device to process the specimen and perform the analysis. The time required for results varies depending on the specific test and device.

Interpretation of Results

- Interpret the results of the test based on the device's display or color changes. Follow the manufacturer's guidelines for result interpretation.

Peripheral Blood Smears

A blood smear is a film of blood on a glass slide. This allows the cells to be viewed under a microscope.

Collecting the Blood Smear Sample

Collecting a blood smear sample involves spreading a thin layer of blood on a microscope slide to examine the cellular components, such as red blood cells, white blood cells, and platelets, under a microscope. A blood smear is often part of a complete blood count (CBC) and may provide additional information about blood cells' size, shape, and distribution.

Gather Necessary Supplies:

- Microscope slides
- Coverslips
- Blood collection tube with anticoagulant (e.g., EDTA tube)
- Lancet or needle
- Alcohol swabs
- Gloves
- Gauze or cotton balls

Prepare the Patient:

- Explain the procedure to the patient to alleviate any concerns.
- Ensure the patient is in a comfortable position with easy access to the arm.

Select and Clean the Puncture Site:

- Choose a puncture site, typically on the fingertip, and clean it with an alcohol swab.
- Allow the site to air-dry or use sterile gauze to pat it dry.

Prepare the Blood Collection Tube:

- Select an appropriate blood collection tube with anticoagulant (e.g., EDTA) to prevent clotting.
- Ensure that the tube is labeled with the patient's information.

Collect Blood by Puncture:

- Use a lancet or needle to make a small puncture at the cleaned site.
- Allow blood to form a small drop at the puncture site.

Touch the Blood Drop to the Slide:

- Gently touch the edge of the microscope slide to the blood drop, allowing the blood to spread along the slide's edge.

Create the Blood Smear:

- Hold another slide at a 30–45-degree angle against the first slide with the blood drop.
- Pull the second slide backward, creating a thin, even blood smear along the first slide.

Air-Dry the Smear:

- Allow the blood smear to air-dry completely. Do not blow on the smear as it may introduce contaminants.

Fixation (Optional):

- Some laboratories may choose to fix the blood smear with methanol or other fixatives to preserve cell morphology.

Stain the Blood Smear:

- Once the smear is dry, it can be stained using a suitable blood stain, such as Wright's stain or Giemsa stain.

Cover the Smear:

- Place a coverslip over the stained blood smear carefully to protect it and provide a clear view under the microscope.

Examine Under the Microscope:

- Examine the stained blood smear under a microscope, starting with low magnification and progressing to higher magnifications.
- Observe the various blood cell types, including red blood cells, white blood cells, and platelets.

Interpretation and Reporting:

- Analyze the morphology, size, and distribution of blood cells.
- Report any abnormalities or notable findings in the laboratory report.

Dispose of Materials:

- Properly dispose of used lancets, gloves, and other disposable materials in accordance with biohazard waste disposal guidelines.

Collecting a blood smear allows healthcare professionals to obtain valuable information about the cellular components of blood and aids in the diagnosis and monitoring of various blood-related disorders. Proper technique, labeling, and attention to detail are crucial throughout the blood smear collection process to ensure accurate and reliable results.

Chapter 16: Special Handling Requirements

Temperature, protection from light, and chain of custody are critical considerations in blood collection to maintain the integrity of samples and ensure accurate test results.

Blood Collection Special Requirements

***Arterial Blood Gases*:** According to WHO guidelines, the ABG test requires drawing from a radial artery, usually requiring a pre-heparinized syringe. The sample is iced for transport.

- ABG test requires drawing from a radial artery, usually requiring a pre-heparinized syringe. The sample is *iced for transport*.
- An ABG test is performed to determine arterial blood gasses. The sample may be obtained through a catheter placed in an artery, or it can be obtained using a pre-heparinized needle/syringe to puncture an artery.
- Problems related to ABG testing include air in the sample, venous collection, delay in transport, improper quantity of heparin in the syringe, and improper mixing after drawing blood.
- **Phlebotomist do not perform ABG test.**

Temperature Requirements

- Room Temperature (RT): Some blood samples, such as those for routine chemistry tests, can be transported and stored at room temperature.
- However, specific guidelines may vary, and it's essential to check the requirements for individual tests.
- Refrigerated (2-8°C): Certain samples, including those for some microbiology or coagulation studies, require refrigeration during transportation and storage.

- It's crucial to maintain the specified temperature range to prevent sample degradation.
- Frozen (≤-20°C or ≤-70°C): Some tests, like those involving sensitive analytes or genetic studies, may require freezing the samples at ultra-low temperatures.

Adherence to the recommended temperature range is vital for preserving the stability of these samples.

Protection from Light

- Light-Sensitive Samples: Some analytes, (a substance whose chemical components are identified and measured) such as bilirubin and certain drugs, are sensitive to light. Protect samples from exposure to light during collection, transport, and storage. Use opaque containers or wrap samples in aluminum foil to shield them from light.
- -Specimen Containers: Ensure that specimen containers, especially for light-sensitive tests, are designed to provide adequate protection from ambient light.

Chain of Custody Requirements:

- Purpose: Chain of custody refers to the documentation and procedures used to maintain the integrity and security of a specimen from the time of collection through analysis and reporting.
- Documentation: All individuals handling the specimen, from the collector to the laboratory personnel, must document their actions. This includes the date, time, and signature at each step.
- Transportation Security: Ensure secure and documented specimen transportation from the collection site to the laboratory. This may involve using sealed and labeled containers and tracking systems.
- Access: Control measures implemented to control access to specimens and maintain security. This is crucial for forensic or legal cases where the sample's integrity is essential.

- Tamper-Proof Seals: Use tamper-proof seals on specimen containers to detect unauthorized access or tampering.

These requirements contribute to the quality and reliability of laboratory results, allowing healthcare providers to make informed decisions about patient care.

Adhering to proper temperature conditions, protecting samples from light, and maintaining a secure chain of custody are fundamental principles in ensuring the accuracy and reliability of blood collection and testing procedures.

Healthcare professionals should follow established protocols, guidelines, and regulations to uphold the highest standards in specimen handling and processing.

Blood Donation

Blood donation donor screening is a crucial process designed to ensure the safety of both blood donors and recipients. The screening aims to identify potential risks associated with blood donation and to prevent the transmission of infectious diseases through donated blood.

Blood Donation Screening Process

Registration and Identification

- Donors are required to provide identification and complete a registration process. Personal information, such as name, address, and contact details, is collected.

Confidential Health History Questionnaire

- Donors are given a confidential health history questionnaire to assess their eligibility to donate blood.

- The questionnaire covers information related to the donor's health, lifestyle, recent travel, and potential exposure to infectious diseases.

Health History Review

- A healthcare professional reviews the donor's health history questionnaire with the donor, addressing any concerns or clarifying information.

Mini-Physical Examination

- A brief physical examination may be conducted to assess the donor's general health. This may include checking vital signs such as blood pressure, pulse, and temperature.

Hemoglobin Testing

- Hemoglobin levels are checked to ensure that the donor has an adequate amount of red blood cells. This is often done through a fingerstick or a small blood sample.

Infectious Disease Screening

Donors are screened for infectious diseases, including but not limited to:

- HIV (Human Immunodeficiency Virus)
- Hepatitis B and C
- Syphilis
- West Nile Virus
- Chagas disease
- Zika virus

Malaria Screening

- Donors may be asked about recent travel to malaria-endemic areas, and if applicable, additional testing or deferral measures may be implemented.

Medication and Risk Assessment

- Donors are asked about medications they may be taking, as certain medications or medical conditions may affect eligibility to donate.

Risk Behavior Assessment

- Questions related to high-risk behaviors, such as unprotected sexual activity or drug use, are included to assess potential risks for bloodborne infections.

Donor Counseling

- If any concerns or issues arise during the screening process, donors may receive counseling from healthcare professionals to address questions or provide guidance.

Confidentiality and Privacy

- All information obtained during the screening process is kept confidential. Donors' privacy is protected, and their personal health information is handled in compliance with relevant privacy laws and regulations.

Ineligibility and Deferral

- Based on the screening results, donors may be deemed ineligible to donate blood temporarily (deferral) or permanently. Deferral reasons may include recent illness, travel to high-risk areas, or other health considerations.

Education and Thanking the Donor

- Donors are provided with information about the donation process, the importance of their contribution, and any follow-up steps.
- Donors are thanked for their time and commitment to contributing to the blood supply.

Blood donation donor screening is a comprehensive process designed to prioritize the safety of both donors and recipients. Strict adherence to established protocols, guidelines, and regulatory standards helps maintain the integrity of the donated blood supply and reduces the risk of transfusion-transmitted infections. Donors are encouraged to provide honest and accurate information during the screening process to ensure the safety of the blood supply.

Chapter 17: Agency Regulations

Clinical and Laboratory Standards Institute (CLSI)

The Clinical and Laboratory Standards Institute (CLSI) is a globally recognized, nonprofit organization that promotes the development and use of voluntary agreement of standards and guidelines within the healthcare and medical testing community.

Its mission is to develop clinical and laboratory practices and promote their use worldwide, ultimately ensuring high-quality and effective patient care.

Key Aspects of CLSI Standard Development

CLSI develops standards and guidelines through a consistent driven process that balances the viewpoints of industry, government, and healthcare professionals. The standards are recognized globally for their high level of excellence and scientific rigor.

- Scope of Work: CLSI documents cover a variety of subjects, including quality control, method evaluation, point-of-care testing, preanalytical and postanalytical considerations, and molecular diagnostics.
    - The standards apply to a range of settings, from small private clinics to large government laboratories.
- Accreditation and Compliance: While compliance with CLSI guidelines is voluntary, many laboratories adopt them because they are often incorporated into state and federal regulations. Many accreditation bodies use CLSI documents as part of their inspection process, recognizing the high standard of laboratory practice they encourage.
- Global Impact: CLSI's global outreach program provides training, education, and resources to promote the adoption of CLSI standards worldwide, especially in resource-constrained countries.
- Educational Programs and Resources: CLSI offers a range of educational programs and products designed to help laboratories implement its standards and improve their quality of testing. These resources include webinars, workshops, and publications that guide the practical application of standards.

- Operational Impact: For clinical and laboratory settings, adherence to CLSI standards can lead to improvements in the accuracy and reliability of test results, enhancing patient care.

Laboratories that implement CLSI standards may also see operational benefits, such as increased efficiency, reduced error rates, and better management of resources.

Center for Disease Control (CDC)

The CDC provides clinical and public health professionals with both technical assistance and training, helping professionals achieve the highest quality of healthcare.

The CDC, in partnership with CMS and FDA, supports, oversees, and manages the *Clinical Laboratory Improvement Advisory Committee* which assesses, diagnoses, and helps prevent disease.

The CDC and the *Hospital Infection Control Practices Advisory Committee* (HICPAC) make continued updates to the Guidelines. **[2]**

Summaries of recommendations include:

- Administrative Responsibilities
- Education & Training
- Surveillance
- Hand Hygiene
- PPE
- Respiratory Hygiene/cough etiquette
- Patient Placement
- Care of the Environment

Clinical Laboratory Improvement Amendments

(CLIA)The Clinical Laboratory Improvement Amendments (CLIA) of 1988 are United States federal regulatory standards that apply to all clinical laboratory testing performed on humans, except clinical trials and basic research.

CLIA aims to ensure the accuracy, reliability, and timeliness of test results regardless of where the test was performed.

The Centers for Medicare & Medicaid Services (CMS), in collaboration with the Food and Drug Administration (FDA) and the Centers for Disease Control and Prevention (CDC), play a pivotal role in ensuring laboratory quality and safety by enforcing these standards.

Key Components of CLIA

- Certification: CLIA requires that any facility performing laboratory testing to obtain clinical information for diagnosis, treatment, or health assessment must first obtain certification. The type of certification required depends on the complexity of the tests performed.
- Test Categorization: Tests are categorized by CLIA based on their complexity, ranging from waived tests (simple tests with a low risk for an incorrect result) to moderate and high complexity tests.
- Personnel Qualifications: CLIA outlines specific qualifications for personnel at each level of testing, including directors, clinical consultants, supervisors, testing personnel, and others, to ensure they are competent to perform laboratory testing and reporting.
- Proficiency Testing: Laboratories must enroll in a CMS-approved proficiency testing program for each of the regulated analytes that they test. This involves testing unknown samples sent by the proficiency testing program and achieving satisfactory performance.
- Quality Systems: Laboratories are required to establish and follow written policies and procedures for all phases of the total testing process (pre-analytic, analytic, and post-analytic) as well as general laboratory systems. Post-analytic errors often, but not always, relate to diagnostic errors after blood has been drawn.
    - This ensures the quality and reliability of test results.
- Inspections: Laboratories are subject to regular inspections to ensure compliance with CLIA standards.

These inspections can be conducted by CMS directly or by CMS-approved accrediting organizations.

Importance of CLIA

- Quality Assurance: Ensures the quality and reliability of laboratory testing.

- Public Health: Contributes to the overall improvement of public health by ensuring accurate and reliable laboratory testing results.
- Standardization: Provides a standardized approach to laboratory testing, ensuring consistency in the quality of testing across different facilities.
- Consumer Protection: Protects patients and consumers by requiring laboratories to meet certain performance standards.
- Compliance with CLIA: Laboratories must adhere to specific requirements based on the complexity of the tests they perform.

Noncompliance can result in penalties, suspension of the laboratory's CLIA certificate, and cessation of laboratory testing operations.

Waived

In the context of the Clinical Laboratory Improvement Amendments (CLIA), "waived" refers to a category of laboratory tests that are considered simple and carry a minimal risk of an incorrect result.

CLIA-waived tests are distinguished from more complex tests by the fact that the likelihood of erroneous results is negligible, or the tests pose no reasonable risk of harm to the patient if performed incorrectly.

Characteristics of Waived Tests

- Simplicity: Waived tests are simple to perform and do not require complex laboratory equipment or highly specialized personnel.
    - The procedures are often straightforward, involving a few steps that are easy to follow.
- Low Risk of Error: These tests have been shown to have a low risk of error.
    - They are designed in such a way that there is minimal chance that mistakes in the testing process will lead to incorrect results.
- Use in Various Settings: Because of their simplicity and safety, waived tests can be performed in a variety of settings, not just in traditional laboratory environments.
    - This includes places like physicians' offices, clinics, and even patient homes in some cases.

CLIA Waived Test Process

- FDA Approval: For a test to be categorized as CLIA waived, it must be approved by the Food and Drug Administration (FDA).

    - The manufacturer of the test must apply to the FDA demonstrating that the test meets the criteria for waiver—which includes simple methodology and low risk of incorrect results.
- Obtaining a CLIA Certificate: Facilities that wish to perform only waived tests must obtain a Certificate of Waiver from the Centers for Medicare & Medicaid Services (CMS). This involves enrolling in the CLIA program and paying a fee every two years.

Compliance with CLIA

- Standards: Even though waived tests are less complex, facilities performing these tests must still comply with certain CLIA standards. This includes following the manufacturer's test instructions and maintaining proper documentation.
- Examples of CLIA Waived Tests: Urine pregnancy tests, blood glucose monitoring for diabetes, Strep throat tests (rapid strep test), Influenza tests, and Fecal occult blood tests.
- Significance of CLIA-Waived Tests: CLIA-waived tests play a crucial role in healthcare by providing quick and reliable results, which is essential for the timely diagnosis and management of many conditions.

Their ease of use and the minimal risk involved make them suitable for a wide range of healthcare settings, including point-of-care testing, where immediate results can significantly impact clinical decision-making and patient care.

While the procedures for waived tests are designed to be straightforward, it's still important for personnel performing these tests to be properly trained and for the tests to be conducted according to the manufacturer's instructions and CLIA regulations to ensure accuracy and reliability.

Provider-Performed Microscopy Procedures (PPMP)

Provider-Performed Microscopy Procedures (PPMP) is a category within the Clinical Laboratory Improvement Amendments (CLIA) regulations that refer to certain *moderate complexity microscopic examinations performed by physicians, mid-level practitioners* (such as nurse practitioners and physician assistants), or dentists during a patient's visit.

These healthcare providers are allowed to perform specific microscopy procedures as part of their patient examination and are exempt from the regulatory requirements that apply to moderate complexity testing, provided certain conditions are met.

Characteristics of PPMP Specific Procedures: PPMP includes a limited set of microscopy procedures, such as wet mounts (including preparations of vaginal, cervical, or skin specimens), potassium hydroxide (KOH) preparations, pinworm examinations, fern tests, post-coital direct qualitative examinations of vaginal or cervical mucous, urine sediment examinations, nasal smears for granulocytes, and fecal leukocyte examinations.

Performed by Eligible Providers: Only certain providers, including physicians, mid-level practitioners (like nurse practitioners, and physician assistants), and dentists, are allowed to perform these microscopy procedures under PPMP.

Performed During Patient Visit: The microscopy procedures must be performed by the eligible provider at the time of the patient visit in a setting where immediate treatment can be administered based on the test results.

Requirements for PPMP CLIA

Certificate: The facility where the PPMP is performed must have a CLIA certificate for Provider-Performed Microscopy Procedures.

Proficiency Testing: While PPMP is not subject to all the same requirements as moderate complexity tests, the provider must still participate in proficiency testing for each type of PPMP that they perform.

Quality Control and Assurance: Providers must implement quality control procedures for the tests they perform and participate in an ongoing quality assurance program that assesses the quality of the microscopy work.

Proper documentation of the procedures, quality control measures, and results is required.

Significance of PPMP

PPMP allows for the rapid examination and diagnosis of patient samples, enabling immediate clinical decision-making and treatment.

This is especially important in settings where quick turnaround is crucial for patient care, such as in primary care offices, emergency rooms, or rural clinics where access to full laboratory services may be limited.

While PPMP offers convenience and rapid results, the providers performing these tests must be adequately trained in microscopic techniques, understand the limitations of the tests they are performing, and are aware of the importance of quality control and accurate documentation.

Proper adherence to PPMP regulations ensures the reliability of test results and the safety of patient care.

Moderate Complexity

Moderate complexity testing, as defined by the Clinical Laboratory Improvement Amendments (CLIA), refers to a category of laboratory tests that are more complex than waived tests but not as complex as high-complexity tests.

These tests require a certain level of expertise, equipment, and quality measures to ensure accuracy and reliability but do not involve the same degree of complexity as high-complexity tests.

Characteristics of Moderate Complexity Tests

Procedural Complexity: Moderate complexity tests involve procedures that are more complex than waived tests. This may include automated processes, manual techniques, or a combination of both.

Quality Control Requirements: Laboratories performing moderate complexity tests must adhere to more stringent quality control standards compared to waived tests. This includes regular performance of control checks, calibration, and maintenance of equipment.

Personnel Qualifications: Personnel performing moderate complexity tests must meet higher qualifications than those performing waived tests. This includes specific training and education requirements, as well as competency assessments.

Proficiency Testing: Laboratories must participate in proficiency testing programs for each moderate complexity test performed. This involves testing unknown samples sent by an external agency and achieving satisfactory performance.

Requirements for Performing Moderate Complexity Tests CLIA

Certification: A laboratory must obtain a CLIA certificate that is appropriate for the level of testing performed, including moderate complexity tests.

Supervision and Oversight: A laboratory director with the qualifications specified by CLIA must oversee the laboratory operations. There are also specific requirements for clinical consultants, technical supervisors, and testing personnel in terms of education, experience, and responsibilities.

Quality Systems: Laboratories must implement a quality system that covers all aspects of testing, from pre-analytic to post-analytic processes. This includes specimen handling, test performance, result reporting, equipment maintenance, and corrective actions when problems are identified.

Documentation and Record Keeping: Accurate and comprehensive documentation is essential. This includes records of test performance, quality control measures, maintenance activities, and personnel competency assessments.

Inspections and Compliance: Laboratories performing moderate complexity tests are subject to routine inspections to ensure compliance with CLIA standards. Noncompliance can result in penalties, including suspension of the laboratory's CLIA certificate.

Examples of Moderate Complexity Tests:

- Certain chemistry tests (e.g., electrolyte panels, liver function tests)
- Hematology tests (e.g., complete blood counts)
- Immunology tests (e.g., ELISA tests for various infections)
- Some microbiology tests (e.g., culture and sensitivity tests)

Importance of Moderate Complexity Testing:

Moderate complexity tests are vital for the diagnosis, monitoring, and treatment of various conditions. The results from these tests provide valuable information that healthcare providers use to make informed clinical decisions.

Ensuring the accuracy and reliability of these tests through compliance with CLIA regulations is crucial for patient safety and effective healthcare delivery.

High Complexity: High complexity testing, as defined under the Clinical Laboratory Improvement Amendments (CLIA), represents the most complex category of laboratory testing.

Tests classified as high complexity typically require a high level of expertise, both in terms of the technical performance of the test and the interpretation of results.

These tests often involve manual procedures, sophisticated instruments, and a significant degree of judgment and interpretation by the testing personnel.

Characteristics of High-Complexity Tests

- Technical Complexity: High-complexity tests often involve multiple steps, intricate procedures, or unique methodologies that require a high degree of skill and technical expertise.
- Interpretation and Judgment: These tests frequently require substantial professional interpretation and judgment to analyze results and may also require correlation with clinical data.
- Equipment and Environment: High-complexity testing often requires specialized equipment and a controlled laboratory environment to ensure the precision and accuracy of test results.

Requirements for Performing High-Complexity Tests

CLIA Certification: Laboratories performing high-complexity tests must obtain a CLIA certificate specifically for high-complexity testing. This involves a more rigorous application and inspection process.

Examples of High Complexity Tests:

- Molecular diagnostics, including advanced genetic and genomic testing.
- Certain types of cancer diagnostics, including some histopathological examinations.
- Complex microbiological tests, such as antibiotic susceptibility testing for uncommon or highly resistant organisms.
- Flow cytometry for immunophenotyping or cell sorting.

Importance of High Complexity Testing

High complexity tests are essential in the modern healthcare landscape, often providing critical information for the diagnosis, prognosis, and treatment of complex diseases.

They are particularly crucial in fields like oncology, genetics, and infectious diseases.

Given the complexity and the potential impact of these tests on patient care, maintaining the highest standards of accuracy, reliability, and interpretability through strict compliance with CLIA regulations and other quality standards is paramount.

Personnel Qualifications

- Laboratory Director: Must meet stringent education and experience requirements, often needing a doctorate in a relevant field or substantial experience in laboratory science.
- Technical Supervisor: Responsible for the technical and scientific oversight of the laboratory, requiring high qualifications in terms of education and experience.
- Clinical Consultant: Provides clinical expertise and ensures the appropriateness and quality of the laboratory's contribution to patient care.
- Testing Personnel: Must meet specific requirements for education, training, and competency.
- Quality Control and Assurance: High-complexity labs must adhere to strict quality control and quality assurance protocols.

    - This includes regular performance of control checks, calibration, and equipment maintenance, along with comprehensive documentation of these activities.
- Proficiency Testing: Participation in proficiency testing for each high-complexity test performed is mandatory.
    - The lab must analyze unknown samples and compare results with other labs to ensure testing accuracy and reliability.
- Record Keeping and Documentation: Meticulous record-keeping is crucial, including documentation of test methodologies, quality control measures, equipment maintenance, and personnel qualifications and training.

Safety Protocols in Clinical and Laboratory Settings

Safety protocols are essential in clinical and laboratory settings to protect staff, patients, and visitors from potential hazards. These protocols encompass a broad range of practices, from handling biological specimens and hazardous chemicals to ensuring overall workplace safety.

Critical safety protocols in clinic and lab settings

Biological Safety Infection Control: Implementing standard precautions to prevent the spread of infections, including the use of personal protective equipment (PPE), hand hygiene practices, and safe injection practices.

Biosafety Levels: Adhering to the four biosafety levels (BSL-1 to BSL-4) depending on the infectious agents being handled. Each level has specific containment practices and laboratory facilities.

Specimen Handling: Ensuring proper collection, labeling, transportation, and disposal of biological specimens to minimize the risk of exposure and contamination.

Chemical Safety Chemical Hygiene Plan: Developing and implementing a plan to minimize exposure to hazardous chemicals. This includes proper labeling, storage, and handling procedures.

Material Safety Data Sheets (MSDS)/Safety Data Sheets (SDS): Providing access to MSDS/SDS for all chemicals, detailing the hazards, handling, storage, and disposal procedures.

An MSDS is not required for isopropyl alcohol.

However, all hazardous products and/or hazardous chemicals must be accompanied by an MSDS that lists chemical properties and toxicology, precautions, data, storage, and more.

Personal Protective Equipment (PPE): Ensuring the availability and proper use of PPE, such as gloves, goggles, and lab coats, when handling chemicals.

Physical Safety

Ergonomics: Designing workstations and procedures to minimize strain and prevent musculoskeletal disorders, especially for staff who work with microscopes or perform repetitive tasks.

Emergency Preparedness: Having clear procedures for dealing with emergencies, including spills, fires, and exposure incidents.

This includes proper first aid measures and readily available emergency equipment like eyewash stations and safety showers.

Equipment Maintenance: Regularly inspecting, maintaining, and calibrating laboratory equipment to ensure it is safe and functional.

Radiation Safety Controlled Areas: Designating areas for the use of radioactive materials and restricting access to authorized personnel only.

Radiation Monitoring: Monitoring levels of radiation exposure using dosimeters and ensuring they do not exceed regulatory limits.

Training and Protocols: Providing specialized training for handling radioactive materials and establishing protocols for storage, use, and disposal.

Waste Management

Segregation and Labeling: Properly segregating (e.g., biohazardous, chemical, radioactive) and labeling waste to ensure it is handled and disposed of correctly.

Disposal Procedures: Following established procedures for the safe disposal of all types of hazardous waste, including sharps, biological waste, chemical waste, and radioactive waste.

Training and Compliance Regular Training: Conduct regular safety training sessions for all staff members to ensure they are aware of potential hazards and know how to work safely.

Compliance with Regulations: Adhering to local, state, and federal regulations, as well as guidelines from bodies like OSHA, CDC, and CLIA, to ensure a safe working environment.

OSHA

The Occupational Safety and Health Administration (OSHA) is an agency of the United States Department of Labor. OSHA's mission is to ensure safe and healthful working conditions for working men and women by setting and enforcing standards and by providing training, outreach, education, and assistance.

Key aspects of OSHA guidelines

1. Hazard Communication
    a. *Purpose:* To ensure that the hazards of all chemicals produced or imported are classified, and that information concerning the classified hazards is transmitted to employers and employees.
    b. In healthcare, it is each individual's right to know the chemicals to which they might be exposed. OSHA regulates, promotes, and enforces the right-to-know law, and individuals can call or write to report, file a complaint, or ask questions.
    c. *Requirements*: Labeling of hazardous chemicals, provision of *Safety Data Sheets* (SDS), and proper training for workers.
2. Bloodborne Pathogens Standard
    a. *Purpose*: To protect workers from the health hazards caused by bloodborne pathogens.
    b. *Requirements:* Establishing an Exposure Control Plan, implementing the use of standard precautions, using personal protective equipment

(PPE), offering Hepatitis B vaccinations, providing post-exposure evaluation and follow-up, and training employees.

3. Personal Protective Equipment (PPE)
    a. *Purpose*: To protect workers from various hazards in the workplace such as chemicals, physical, electrical, heat, and biohazards.
    b. *Requirements:* Conducting a hazard assessment, providing appropriate PPE for employees, and training employees on the use and care of PPE.
4. Respiratory Protection
    a. *Purpose:* To protect workers from insufficient oxygen environments or harmful dust, fogs, smoke, mists, gases, vapors, and sprays.
    b. *Requirements*: Providing appropriate respirators when necessary, ensuring proper fit-testing and training, and establishing a respiratory protection program.
5. Recordkeeping and Reporting
    a. *Purpose:* To require employers to record and report work-related fatalities, injuries, and illnesses.
    b. *Requirements*: Keeping a log of work-related injuries and illnesses (OSHA Form 300), posting an annual summary (OSHA Form 300A), and reporting any work-related fatalities, inpatient hospitalizations, amputations, or losses of an eye.
6. Exit Routes and Emergency Planning
    a. *Purpose:* To ensure that all workplaces have enough exit routes and proper emergency action plans.
    b. *Requirements*: Developing and implementing an emergency action plan, maintaining clear and unobstructed exit routes, and providing appropriate fire prevention plans.
7. Ergonomics
    a. *Purpose*: To prevent musculoskeletal disorders in workers caused by repetitive motions or overexertion.
    b. *Requirements*: Identifying risk factors, providing training, and implementing appropriate measures to reduce ergonomic hazards.
8. Lockout/Tagout Procedures
    a. *Purpose*: To ensure that machines are properly shut off and not able to be started up again before the completion of maintenance or servicing work.

b. *Requirements*: Develop a lockout/tagout program including energy control procedures, employee training, and periodic inspections.

Compliance and Enforcement

OSHA ensures compliance primarily through workplace inspections and investigations. Compliance with OSHA standards can prevent fines and reduce workplace injuries and illnesses.

Standard Precautions

Standard Precautions are a set of infection control practices used to prevent the transmission of diseases that can be acquired by contact with blood, body fluids, non-intact skin (including rashes), and mucous membranes.

These measures are the basic level of infection control that should be used in the care of all patients all the time.

Standard Precautions are designed to reduce the risk of transmission of microorganisms from both recognized and unrecognized sources of infection.

Key components of Standard Precautions:

Hand Hygiene

- *Description:* Washing hands with soap and water or using an alcohol-based hand sanitizer.
- *When to Use*: Before and after touching a patient, after contact with bodily fluids or contaminated surfaces, before performing an aseptic task, and after removing gloves.

Use of Personal Protective Equipment (PPE)

- *Description:* Wearing gloves, gowns, masks, and eye protection to protect skin and mucous membranes from exposure to pathogens.
- *When to Use*: When there's a potential for contact with blood, body fluids, secretions, excretions, non-intact skin, and mucous membranes.

Respiratory Hygiene/Cough Etiquette

- *Description*: Covering mouth and nose with a tissue when coughing or sneezing, disposing of tissues in a waste receptacle, and performing hand hygiene after contact with respiratory secretions.
- *When to Use*: For all individuals with signs of illness or those caring for them.

Safe Injection Practices

- *Description*: Using an aseptic technique for the preparation and administration of parenteral medications.
- *When to Use*: During the preparation and administration of injected medications.

Safe Handling of Potentially Contaminated Equipment or Surfaces

- *Description*: Proper cleaning and disinfection of patient care equipment and environmental surfaces.
- *When to Use*: After equipment and surfaces are visibly soiled or used in the care of a patient.

Patient Placement

- *Description:* Placing a patient in a private room if they are at risk of spreading pathogens to others or if they are at increased risk of infection.
- *When to Use*: For patients who are known or suspected to have an infection that can be transmitted in healthcare settings.

Linen Handling

- *Description*: Handling, transporting, and processing used linen in a manner that prevents skin and mucous membrane exposures, contamination of clothing, and transfer of microorganisms to other patients and environments.
- *When to Use*: When dealing with linens contaminated with bodily fluids or when moving linens from patient rooms.

Importance of Standard Precautions:

Standard Precautions are based on the principle that all blood, body fluids, secretions, excretions (except sweat), non-intact skin, and mucous membranes may contain transmissible infectious agents.

They are applied to all patients receiving care in hospitals, regardless of their diagnosis or presumed infection status.

Adherence to Standard Precautions is crucial in preventing healthcare-associated infections (HAIs), protecting patients as well as healthcare workers from potential infections, and creating a safe healthcare environment.

The Joint Commission

The Joint Commission is a United States-based nonprofit organization that accredits and certifies more than 22,000 healthcare organizations and programs.

It is recognized nationwide as a symbol of quality that reflects an organization's commitment to meeting certain performance standards. The commission's goal is to *improve healthcare for the public*, in collaboration with other stakeholders, by *evaluating healthcare organizations* and inspiring them *to excel in providing safe and effective care* of the highest quality and value.

Key Functions of The Joint Commission

Accreditation and Certification: The Joint Commission accredits and certifies healthcare organizations and programs across a range of settings, including hospitals, doctor's offices, nursing homes, office-based surgery centers, behavioral health treatment facilities, and providers of home care services.

Accreditation and certification by The Joint Commission are recognized as symbols of quality that reflect an organization's commitment to meeting certain performance standards.

- Setting Standards: The Joint Commission develops its standards in consultation with healthcare experts, providers, measurement experts, and patients. The standards focus on improving the quality and safety of patient care.
    - They are updated regularly to reflect changes in healthcare and in response to emerging safety issues.
- On-site Surveys: The Joint Commission conducts regular on-site surveys to assess compliance with its standards. These surveys are unannounced and

are conducted by a team of healthcare professionals, including doctors, nurses, hospital administrators, and others.
    - The surveyors assess the organization's performance in areas that affect patient care and safety.
- Quality Improvement: The Joint Commission provides support to healthcare organizations in their quality improvement efforts.
    - It offers educational programs and publications to help staff at all levels understand the requirements and implement changes.
    - It also shares best practices and lessons learned from other organizations, facilitating a collaborative approach to quality improvement.
- Reporting and Data Collection: The Joint Commission collects and analyzes data from accredited organizations to identify trends and areas for improvement.
    - It provides organizations with data about their performance compared to similar organizations.
- Public Information: The commission provides information to the public about how accredited organizations perform.
    - This information can help consumers make informed choices about where to receive healthcare.
    - It also uses this data to influence the standards and education it provides to healthcare organizations.

Importance of The Joint Commission

Quality Assurance: Accreditation and certification by The Joint Commission serve as an external seal of approval for quality and safety.

Risk Reduction: The standards and evaluation process help healthcare organizations identify and mitigate risks, enhancing patient safety.

Market Differentiation: Accreditation is a powerful marketing tool, demonstrating an organization's commitment to quality to patients, insurers, and the community.

Continuous Improvement: The Joint Commission's resources support continuous improvement, helping organizations to stay up to date with best practices in patient care.

The National Patient Safety Goals

The National Patient Safety Goals (NPSGs) are a critical set of guidelines developed by The Joint Commission to help accredited organizations address specific areas of concern in regards to patient safety.

The NPSGs are revised annually based on input from practitioners, literature reviews, and advisories from an advisory panel composed of nurses, physicians, pharmacologists, risk managers, and other experts who have hands-on experience in their respective fields.

Purpose of the National Patient Safety Goals

- The main aim of the NPSGs is to promote specific improvements in patient safety by highlighting problematic areas in healthcare and describing evidence-based solutions to these problems.
- These goals focus on system-wide solutions, wherever possible, for issues including the identification of patients at risk for suicide, the prevention of infection, and the improvement of staff communication.

Key Areas Addressed by the NPSG

- *Improve the accuracy of patient identification*: Use at least two patient identifiers (not including the patient's room number) to ensure that each patient gets the correct medicine and treatment.
- *Improve staff communication*: Ensuring that test results and other critical patient information are conveyed timely and clearly among healthcare providers.
- *Prevent infection*: Following guidelines for hand hygiene and other infection control practices from the Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO). **[2]**
- *Prevent medication errors*: Label all medications, medication containers, and other solutions on and off the sterile field in perioperative and other procedural settings.
- *Prevent patient harm resulting from falls*: Implementing strategies to reduce the risk of falls for patients.
- *Prevent bed sores (pressure ulcers):* Assessing patients' skin condition upon their admission and periodically during their stay, and adopting preventive measures, especially for high-*risk patients.*

- *Prevent healthcare-associated infections (HAIs):* Following evidence-based practices to prevent infections that are difficult to treat, such as methicillin-resistant Staphylococcus aureus (MRSA), and central line-associated bloodstream infections.
- *Prevent surgical mistakes*: Ensuring correct site, correct procedure, and correct patient surgery.

Implementation of the NPSGs

Healthcare organizations are expected to integrate these goals into their processes and ensure that their staff is educated and trained to follow them.

The Joint Commission assesses compliance with these goals during their accreditation surveys and continuous compliance monitoring.

Chapter 18: Laws and Regulations

Malpractice

Malpractice, particularly in the medical field, refers to professional negligence by a healthcare provider or practitioner. It occurs when a healthcare professional fails to provide the standard of care expected in their field, leading to patient harm, injury, or death. Understanding malpractice is crucial for both healthcare professionals and patients, as it concerns the legal and ethical dimensions of healthcare.

Types of Medical Malpractice:

Medical malpractice can take various forms, including but not limited to:

- *Misdiagnosis or Delayed Diagnosis*: Failing to diagnose a condition correctly or promptly, potentially leading to incorrect or delayed treatment.
- *Treatment Errors*: Administering the wrong treatment, medication errors, or performing a procedure incorrectly.
- *Surgical Errors*: Mistakes during surgery, such as operating on the wrong site or leaving surgical instruments inside the patient's body.
- *Birth Injuries*: Negligence during childbirth, leading to injury to the baby or mother.
- *Failure to Inform or Obtain Consent*: Not providing sufficient information about the risks and alternatives related to a treatment or failing to obtain informed consent from the patient.

Elements of a Malpractice Claim

To establish a case of medical malpractice, certain elements must be proven.

- *Duty of Care*: A professional relationship exists between the healthcare provider and the patient, establishing a duty of care.
- *Breach of Duty*: The healthcare provider failed to meet the standard of care that a reasonably competent professional would have provided under similar circumstances.
- *Causation*: There is a direct causal link between the provider's negligence and the patient's harm.
- *Damages*: The patient suffered quantifiable harm because of the breach, such as physical injury, additional medical bills, or loss of income.

Preventing Malpractice

Healthcare providers can take several steps to mitigate the risk of malpractice:

- Adhering to Standard Protocols: Following established medical protocols and guidelines diligently.
- Communication: Ensuring clear and open communication with patients about their diagnoses, treatment options, and associated risks.
- Documentation: Keeping thorough and accurate medical records for every patient.
- Continuing Education: Staying updated with the latest medical practices, technologies, and legal requirements.
- Risk Management: Implementing effective risk management strategies in healthcare settings.

Legal Aspects

Victims of medical malpractice may seek legal recourse to obtain compensation for their injuries and losses. This typically involves filing a lawsuit against the healthcare provider or institution. The legal process can be complex and may require expert testimony to establish the standard of care and how it was breached.

Risk Management

This is a systematic process of identifying, assessing, and controlling threats to an organization's capital and earnings. These threats, or risks, could stem from a wide variety of sources, including financial uncertainty, legal liabilities, strategic management errors, accidents, and natural disasters. A robust risk management strategy is vital for businesses, healthcare organizations, government agencies, and many other entities, as it helps them prepare for the unexpected by minimizing risks and extra costs before they occur.

Key Components of Risk Management

Risk management typically involves the following key components.

- Risk Identification: Recognizing potential risks that could negatively affect an organization's ability to conduct business. This includes risks associated with market changes, legal liabilities, management errors, financial processes, and accidents, among others.

- Risk Analysis: Understanding the nature of the risk and its potential to affect project goals and objectives. This includes aligning the type of risk with the potential impact and determining the likelihood of its occurrence.
- Risk Assessment and Evaluation: Comparing estimated risks against risk criteria that the organization has already established. Risks are prioritized in this step based on their potential impact on business objectives.
- Risk Mitigation Strategies: Developing strategies to manage and mitigate risks. This could involve.
- Risk Avoidance: Changing plans to avoid the risk.
- Risk Reduction: Taking actions to reduce the likelihood or impact of the risk.
- Risk Sharing: Sharing the risk with partners or stakeholders.
- Risk Retention: Accepting the risk and budgeting for it.

Implementation of the Risk Management Plan

Applying the risk management procedures and allocating resources and responsibilities.

- Monitoring and Review of the Plan: Continuously monitoring and reviewing the plan to ensure its effectiveness, making improvements as required.
- Communication and Consultation: Regularly communicating and consulting with stakeholders and team members about risks, their status, and the actions taken to mitigate them.
- Importance of Risk Management: Risk management is important because it.
- Protects Resources: Helps safeguard an organization's physical, human, and financial assets.
- Improves Decision Making: Provides a structured framework for identifying and understanding risks, which can lead to better decision-making regarding all areas of the business.
- Compliance: Ensures the organization complies with legal requirements and industry regulations.
- Stakeholder Confidence: Increases stakeholders' confidence in the organization's ability to manage risks.
- Business Continuity: Ensures the continuity of operations and reduces the likelihood and impact of negative events on business operations.

Challenges in Risk Management

Despite its importance, risk management faces several challenges, such as:

- Complexity of Risks: The modern business environment is dynamic and complex, making risk identification and assessment increasingly challenging.
- Resource Allocation: Determining the right number of resources to allocate can be difficult, especially for less quantifiable risks.
- Changing Nature of Risk: As the business environment evolves, new types of risks emerge, requiring continuous monitoring and adaptation of risk management strategies.
- Integration into Organizational Culture: Embedding risk management into the daily activities of an organization can be challenging, but it is essential for its effectiveness.

Health Insurance Portability and Accountability Act (HIPAA)

The Health Insurance Portability and Accountability Act (HIPAA) is a significant regulatory standard in the United States that was enacted in 1996. It sets the standard for the protection of sensitive patient data.

Organizations that deal with protected health information (PHI) must ensure that all the required physical, network, and process security measures are in place and followed.

HIPAA is composed of several key components and rules that outline the requirements for the protection and confidential handling of medical information.

Key Components of HIPAA

- Title I: Insurance Reform: Protects health insurance coverage for workers and their families when they change or lose their jobs. Prohibits group health plans from denying coverage to individuals with specific diseases and pre-existing conditions, and from setting lifetime coverage limits.
- Title II: Administrative Simplification: Requires the establishment of national standards for electronic healthcare transactions. Mandates the implementation of national identifiers for providers, health insurance plans, and employers. Significantly, it also addresses the security and privacy of health data through the following rules.

- Privacy Rule: Establishes national standards for the protection of individually identifiable health information. It requires appropriate safeguards to protect the privacy of personal health information and sets limits and conditions on the uses and disclosures that may be made of such information without patient authorization.
- Security Rule: Specifies a series of administrative, physical, and technical safeguards for covered entities to use to assure the confidentiality, integrity, and availability of electronic protected health information (e-PHI).
- Breach Notification Rule: Requires covered entities to notify affected individuals, the U.S. Department of Health & Human Services (HHS), and in some cases, the media of a breach of unsecured PHI.
- Enforcement Rule: Contains provisions relating to compliance and investigations, the imposition of civil money penalties for violations of the HIPAA Administrative Simplification Rules, and procedures for hearings.

Importance of HIPAA

Protects Patient Privacy: Ensures that individuals' health information is properly protected while allowing the flow of health information needed to provide high-quality health care.

Security of Health Information: Sets standards for the security of electronic protected health information.

Improves Efficiency in Healthcare: Encourages the use of electronic data interchange in the U.S. healthcare system.

Trust: Builds patient trust by holding the healthcare providers accountable for the confidentiality and security of health information.

Compliance and Penalties Compliance: Covered entities, which include health plans, health care clearinghouses, and health care providers, must comply with the requirements to protect the privacy and security of health information.

Penalties Of Violating HIPAA

Entities that do not comply with HIPAA can face substantial fines. The penalty structure is tiered, based on the nature of the violation and the harm caused, and can extend up to substantial amounts per violation.

HIPAA compliance is a crucial aspect of the healthcare industry, ensuring the confidentiality, integrity, and availability of patient health information.

Regular training and updates on HIPAA regulations are essential for healthcare providers and their business associates to remain compliant and avoid penalties.

Organizations that deal with protected health information (PHI) must ensure that all the required physical, network, and process security measures are in place and followed.

Appendix

Phlebotomy Terminology

General & Procedural Terms

- Phlebotomy - Drawing blood from a vein
- Venipuncture - Puncture of a vein for blood collection
- Capillary Puncture - Collection of blood from skin puncture
- Fingerstick - Capillary puncture on the fingertip
- Heelstick - Capillary puncture in infants
- Basal State - Patient's resting, fasting condition
- Fasting - No food/drink before blood draw
- Order of Draw - Sequence for filling tubes to prevent contamination
- Informed Consent - Permission from patient before procedure
- Standard Precautions - Universal infection-control practices

Anatomy & Veins

- Median Cubital Vein - Primary vein for venipuncture
- Cephalic Vein - Secondary choice vein
- Basilic Vein - Inner arm vein, higher complication risk
- Antecubital Fossa - Inner elbow area where veins are accessed
- Dorsal Hand Veins - Veins on back of hand
- Vein Palpation - Feeling for a vein before puncture
- Artery - Vessel carrying blood away from heart (to be avoided)
- Nerve - Structure near veins; accidental puncture causes pain
- Sclerosed Vein - Hardened vein unsuitable for puncture
- Collapsed Vein - Vein that closes due to too much suction

Equipment

- Tourniquet - Device applied to restrict venous blood flow
- Needle Gauge - Measurement of needle bore size
- Vacutainer - Tube with vacuum for blood draw
- Evacuated Tube System (ETS) - Double-ended needle, holder, and tube system
- Butterfly Needle - Winged infusion set for small veins
- Syringe Method - Manual blood collection with syringe

- Tube Holder - Plastic adapter holding the collection tube
- Lancet - Device for skin puncture
- Alcohol Prep Pad - Used for skin antisepsis
- Gauze Pad - Used to cover puncture site after draw

Tube Colors & Additives

- Red Top - No additive (serum)
- Gold/Tiger Top (SST) - Serum separator tube with clot activator
- Light Blue Top - Sodium citrate, coagulation testing
- Green Top - Heparin, plasma chemistry testing
- Lavender (Purple) Top - EDTA, hematology testing
- Gray Top - Sodium fluoride/potassium oxalate, glucose testing
- Black Top - Sodium citrate, ESR testing
- Yellow Top - ACD or SPS, blood cultures/DNA testing
- Additives - Chemicals preventing clotting or stabilizing samples
- Anticoagulant - Prevents clot formation (e.g., EDTA, citrate, heparin)

Specimen Handling

- Serum - Liquid portion after clotting
- Plasma - Liquid portion with clotting factors
- Whole Blood - Blood sample with all components
- Hematology - Study of blood cells
- Centrifugation - Spinning samples to separate components
- Aliquot - Portion of specimen separated for testing
- Specimen Rejection - Sample not accepted due to errors
- Chain of Custody - Documentation of specimen handling
- Labeling - Correctly identifying patient samples
- Transport - Safe delivery of specimen to lab

Complications & Errors

- Hemolysis - Breakdown of red blood cells in sample
- Hematoma - Collection of blood under the skin
- Petechiae - Small red spots from ruptured capillaries
- Syncope - Fainting during blood draw
- Needlestick Injury - Accidental puncture with a needle
- Infection - Complication from poor aseptic technique
- Nerve Injury - Result of accidental nerve puncture

- Excessive Bleeding - Post-draw complication
- Iatrogenic Anemia - Blood loss from repeated phlebotomy
- Hemoconcentration - Increased concentration of blood components

Safety & Infection Control

- Sharps Container - Disposal container for used needles
- Biohazard - Material containing infectious agents
- PPE (Personal Protective Equipment) - Gloves, gowns, masks, goggles
- Aseptic Technique - Procedures to prevent contamination
- OSHA - Occupational Safety and Health Administration standards
- CLSI - Clinical and Laboratory Standards Institute guidelines
- Isolation Precautions - Infection-control measures for contagious patients
- Hand Hygiene - Proper washing/sanitizing before and after procedures
- Universal Precautions - Treating all specimens as infectious
- Engineering Controls - Safety devices to reduce exposure risk

Special Procedures

- Therapeutic Phlebotomy - Removal of blood for treatment (e.g., hemochromatosis)
- Blood Culture - Sample collection for microbial growth
- Point-of-Care Testing (POCT) - Bedside testing using small samples
- Glucose Tolerance Test (GTT) - Series of blood draws after glucose intake
- Bleeding Time Test - Measures platelet function and clotting ability

<u>Common Laboratory Abbreviations:</u>

- BUN: Blood Urea Nitrogen
- CBC: Complete Blood Count
- DNA: Deoxyribonucleic Acid
- FBS: Fasting Blood Sugar
- HAI: Hospital Acquired Infection (Pneumonia is most common)
- Ig: Immunoglobulin
- Homeostasis - an organism's process of maintaining a stable or steady state
- NPO: Nothing by Mouth
- PBS: Phosphate-Buffered Saline
- OGTT - Oral Glucose Tolerance Test

- QC: Quality Control
- QNS Quantity not sufficient
- RNA: Ribonucleic Acid
- RPM: Revolutions Per Minute (used for centrifuges)
- SDS-PAGE: Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis
- Stat – Immediately
- WBC: White Blood Cell
- RT: Room Temperature
- V/V: Volume per Volume (ratio)
- W/V: Weight per Volume (concentration)

Units of Measurement:

- g: Gram
- L: Liter (1000 ml)
- mL: Milliliter
- µL: Microliter
- mM: Millimolar
- ppm: Parts Per Million
- ppb: Parts Per Billion
- IU: International Units
- rpm: Revolutions Per Minute
- MSDS/SDS: Material Safety Data Sheet / Safety Data Sheet
- PPE: Personal Protective Equipment (e.g., gloves, lab coats, goggles)
- Biosafety Level (BSL): A set of precautions for working with biological agents (e.g., BSL-1, BSL-2).
- CFU: Colony Forming Units
- DNA: Deoxyribonucleic Acid
- Hematology: The study of blood and blood-forming organs
- Hematocrit: the proportion of the total red blood cells to the total blood volume
- Hemolysis is defined as the destruction of red blood cells, a naturally occurring phenomenon as cells age, usually after about 120 days.

Laboratory-related descriptions

- Analyze: The process of examining a sample to determine its composition or properties.

    - Example. Analyzing a blood sample to measure glucose levels or detect the presence of pathogens.
- Calibration: Adjusting or standardizing equipment to ensure accurate and consistent results.
    - Example: Calibrating a glucose meter using a known standard solution before testing patient blood samples.
- Control: A sample with a known value used to verify the accuracy and precision of a test.
    - Example: Using a control sample with a known cholesterol level to ensure a lipid panel test is working correctly.
- Dilution: Reducing the concentration of a sample by adding a solvent (e.g., saline or water).
    - Example: Diluting a blood sample to bring it within the measurable range of an analyzer.
- Incubation: Maintaining a sample at a specific temperature for a set period to allow a reaction to occur.
    - Example: Incubating a blood culture to allow bacteria to grow for identification.
- Reagent: A substance used in a chemical reaction to detect, measure, or produce other substances.
    - Example: Using a reagent to detect the presence of hemoglobin in a blood sample.
- Sample: A small portion of a substance (e.g., blood, urine) collected for testing.
    - Example: Collecting a blood sample from a patient for a complete blood count (CBC).
- Standard: A reference material with a known concentration used to calibrate equipment or validate tests.
    - Example: Using a standard solution with a known glucose concentration to calibrate a spectrophotometer.
- Titration: A method of determining the concentration of a substance in a solution by adding a reagent until a reaction is complete.
    - Example: Titrating a blood sample to determine the concentration of a specific antibody.
- Autoclave: A device that uses steam and pressure to sterilize equipment and materials.

    - Example: Autoclaving phlebotomy needles and tubes to ensure they are sterile before use.
- Fume Hood: A ventilated enclosure used to protect users from inhaling hazardous fumes during experiments.
    - Example: Using a fume hood when handling volatile chemicals for blood sample preservation.
- Limit of Detection (LOD): The lowest concentration of a substance that can be reliably detected by a test.
    - Example: Detecting trace amounts of a drug in a blood sample using a sensitive assay.
- Kilopascal (kPa): A unit of pressure used in laboratory equipment.
    - Example: Measuring the pressure inside an autoclave in kilopascals.
- Molars per Liter (mmol/L): A unit of concentration used in chemistry and biology.
    - Example: Reporting the concentration of sodium ions in blood serum as 140 mmol/L.
- Ultraviolet-visible spectroscopy (UV-Vis): A technique that measures the absorption of ultraviolet or visible light by a sample.
    - Example: Using UV-visible spectroscopy to quantify the concentration of hemoglobin in a blood sample.
- Polymerase Chain Reaction (PCR): A technique used to amplify DNA for analysis.
    - Example: Detecting viral DNA in a blood sample to diagnose an infection.
- Paraformaldehyde: A chemical used as a fixative to preserve tissue or cell samples.
    - Example: Fixing blood cells with paraformaldehyde for microscopic analysis.
- Limit of Quantification (LOQ): The lowest concentration of a substance that can be accurately measured.
    - Example: Quantifying the exact amount of a hormone in a blood sample.
- Gas Chromatography (GC): A technique used to separate and analyze volatile compounds.
    - Example: Analyzing blood alcohol levels using gas chromatography.
- Enzyme-linked immunosorbent Assay (ELISA): A technique used to detect antibodies or antigens in a sample.

    - Example: Testing a blood sample for HIV antibodies using ELISA.
- High-Performance Liquid Chromatography (HPLC): A technique used to separate, identify, and quantify components in a mixture.
    - Example: Measuring drug levels in a blood sample using HPLC.
- Reverse Transcription Polymerase Chain Reaction (RT-PCR): A technique used to amplify RNA by first converting it to DNA.
    - Example: Detecting viral RNA in a blood sample to diagnose COVID-19.
- Colony Forming Units (CFU): A measure of viable bacteria or fungal cells in a sample.
    - Example: Counting CFUs in a blood culture to determine the severity of an infection.
- Atomic Absorption Spectroscopy (AAS): A technique used to measure the concentration of metal ions in a sample.
    - Example: Measuring the concentration of lead in a blood sample using AAS.
- Therapeutic Phlebotomy: Removes blood from patients with certain conditions like hemochromatosis or polycythemia vera to maintain proper blood viscosity and iron levels.
- Techniques in Phlebotomy: Involve various techniques, each suitable for different patients and situations.

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