Introduction: -

Laborato ry instrument is a general term for all kinds of instruments, vessels,
and other tools needed for operations in various laboratories. Which are exposed
to some extreme chemical and physical influences and must at the same time
provide accurate measurem ent results, have a long life, and provide safety for the
user.

Therefore, laboratory instruments have high quality and be meet the high standards
in laboratory technology.

Under this term, we will study in the coming days most of the devices that can
be dealt with in the laboratory.

How do they work? What are their uses? And how do we preserve them?

Laboratory instrument : -

Light Microscope

Electron Microscope

Spectrophotometer

Centrifuge

Incubator

Water bath

Balance

Bunsen burner

Filtration apparatus

Pipettes

Glass wares

Dry oven

Autoclave Chromatography

Dry chemical analyzer

PCR machine Electrophoresis

UV transilluminator

Lab safety: -

A: Personal Protective Equipment (PPE)

Is the effective use of protective gloves, eye and mouth protection, and laboratory coats, all considered to be personal protective devices.

1-Gloves:

Protective gloves must be worn whenever there is potential for direct contact
with infections materia ls and should be discarded in a special waste container
when removed.

2- Goggles:

It must be worn at any time chemicals, heat, or glassware are used.

3- laboratory coats:

Wearing a laboratory coat is very necessary to protect the body and clothes from
germs and chemicals, in addition to preventing the transfer of microbes

outside the
laboratory.

B: Sterilization :

Sterilization is defined as the process where all the living microorganisms, including bacterial spores are killed. Sterilization can be a chieved by physical,
chemical, and mechanical means.

- Use alcohol or wash hands with soap.

C: Waste disposal:

Most laboratories have special waste containers for sharps, radioactive waste,
and organic chemicals.

- Do not throw needles without a cap.
- Ensure that chemicals are safe to dispose of in sewers.
- Don't leave your mess to the next person to clean up.

Note: -

a. Do not bring food and drink into the laboratory.
b. Do not taste or smell the chemicals.
c. Act responsibly in the laboratory and do n ot play with chemicals.
d. Inform the supervisor in the event of any accident.

Lab 2 Microscope First class M.s.c Sura ALshmmeri

Microscope

Types of microscopes :

1-Light microscope : The types of light microscope including: -

A- Bright - field microscope . D -Fluorescent microscope .

B- Dark - field microscopy. E - Phase contrast microscope.

C -Ultraviolet microscope .

2-Electronic microscope: These types are :

A- Scanning electron microscope (SEM).

B-Transmission electron microscope (TEM) .

Bright microscope have two type

A: Simple Microscope:

B: Compound Microscope : It is microscopes which uses visible light anda system of lenses to magnify images of small samples. Main parts of light microscope:

A: Optical parts:

1- Ocular Lenses : The eyepiece consists of a series of lenses mounted in a tube at the upper end of the microscope. It magnifies 10 times.

2- Objective Lenses : The objectives are the lens system closest to the specimen. Most compound microscopes have three or four objectives lenses:

a. The scanning lens (4X).

b. The low -power lens (10X).

c. The high -power lens (40 X)

d. The oil -immersion lens (100 X).

3- The illuminator (Light source): to get light bands and we can control it by brightness adjustment.

4- Condenser: to condense the light.

B: Mechanical parts:

1- Body tube: to carry eye pieces.

2- Arm: to carry eye pieces, objective lenses, stage

3- Revolving disc: for fixing and choosing objective lenses.

4- Stage: to carry slide.

5- Clips: to fix the slide.

6- Adjustment stage: to move the slide right &left --- Forward & backward.

7- Course adjustment: rise stage up & down to get image. (4X,10X)

8- Fine adjustment: rise stage up& down to get clear image. (40X)

9- Diaphragm: control of bands light.

10- Switch on/off.

11- Base :to install the microscope.

Principle of the light microscope : Bands of light fall on the sample and then to the lenses.

Uses:

1- Study of living cells.

2- Study all microorganisms such as bacteria, viruses and protozoa .

3- Criminal investigations.

4- Environmental studies.

5- laboratory analyses.

6- Atomic studies

How to use a compound microscope ? ➢ Place a slide on the stage and fix it with the stage clips. ➢ Switch at on. ➢ Adjust the light and canter it on the specimen. ➢ Adjust the distance between the eyes. ➢ Use X10 Using the coarse adjustment, lower the objective lens down ➢ without Touching the slide. ➢ Look through the eyepiece and rise the stage slowly by using course ➢ adjustment Until appeared image. ➢ Change to X40 and use only fine adjustment until ge t very clear and ➢ Magnification image. ➢ Round the revaluation disc. ➢ Put one drop of oil on the specimen. ➢ Change to X100. ➢ Use only fine adjustment. ➢ When finished, lower the stage, click the low power lens into position and remove the slide. Care & Safety: ❖ Holding the microscope: Always use two hands to move the microscope. Place one hand around the arm, lift the scope, and then put your other hand under the base of the scope for support.

❖ Storing the Microscope : • Bring the platform back down. • Return the lowest power objective in place. • Put it under a protective cover. • Store in a low humidity environment (a dry place).

❖ Cleaning the Microscope • Do not let the microscope get too dirty. • Always use the dust cover when not in use. You can use distal water to remove dust. • To clean the lenses, use a high -quality lens paper (Xylol paper). Do not use facial tissues.

(5) • Clean oil immersion lens with suitable chemicals like Xylene, Naptha and Turpentine.

• Do not use water, alcohol, or acetone beca use oil does not dissolve in it

Light microscope

Electron Microscope

A type of microscope that uses an electron beam instead of light beam to illuminate a specimen and produce an enlarged image.

Types of electron microscope:

There are two main types of electron microscope :

1 -Transmission Electron Microscope (TEM): which detects electrons that pass through a very thin specimen.

2-Scanning electron microscope (SEM): which uses the electrons that are reflected on the surface region of a sample to create an image.

Comparison between light microscope and electron microscope:

Electron microscope	Light microscope
Uses a beam of electrons to view specimens .	Uses light rays to illuminate specimens .
Lenses are made of electromagnets.	Lenses are made of glass .
High resolving power .	Low resolving power.

High magnification. Low magnification.

Very expensive to buy and

maintain. Cheap to buy and has low

maintenance costs.

Images are viewed on a

photographic plate or screen . Images are viewed by the eyes

through the eyepiece.

Operates under a high vacuum. Not used under a vacuum.

Views only dead specimens an

electron microscope cannot be used

to view living specimens as it uses

electrons that are destructive to life. Can view both live and dead

specimens.

Users require technical skills. Simple to use.

Large size. Small size.

Lab 3 **First class** **M.s.c Sura Alshmmeri**

Balance

Balance Is essential laboratory instruments that are widely used for determining weight of various substances such as : *powders ,crystals and chemical materials* in the laboratory for preparing : reagents, stains and culture media , balances are required to weight accurately within the needed range.

Types of balance :

1- ***Beam Balance:*** This type of balance uses ***a comparison technique*** in the form of a beam from which a weighing pan and scale pan are suspended. The object to be weighed is placed on the measuring pan and standard weights are added to the scale pan until the beam is in equilibrium.

Beam Balanc

2- ***Analytical Balance:*** It is used to measure mass to a very high degree of precision. The weighing pans of analytical balance are inside see-

through enclosure with doors so that ***dust does not collect and so any air currents in the room do not affect the delicate balance***

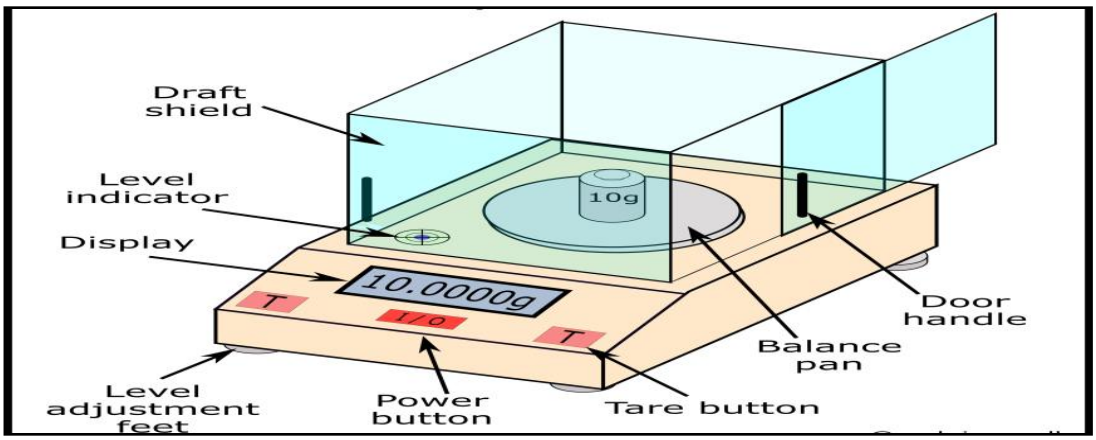
These balances are used

1. To weigh small quantities usually in milligram (mg) range.
2. When great accuracy is required

Analytical Balanc

Parts of analytical balance

- **Pan :** Flat rigid support on which the specimen is placed .
- **Glass doors**: Sliding door , it provide easy access to the inside of the glass case.
- **Digital readout** : To show various numeric information .
- **Zero button**.
- **Calibration button** .



Analytical Balance

Types of Analytical Balance:

A- Single-Pan Mechanical Balance

B-Two-Pan Analytical Balance:

C- Electronic Single-Pan Balance

D- ***Microbalance***

Uses of balances:

1. Read carefully the manufacturer's instructions.
2. Always handle a balance with care.
3. Before starting to weigh, zero the balance as directed by the manufacturer. If using a beam balance, check the position of the beam.
4. Weight the chemicals at room temperature in a weighing scoop or small beaker.
5. Always use forceps to add or remove weights.

Care of balances :

1. Keep balance clean and don't let dirt accumulate near the pivots and bearings.
2. Silica gel should be kept inside the analytical balance case to remove any moisture present in the atmosphere.
3. Protect the weights from dust, moisture and fungal growth.
4. Position the balance on a firm bench away from vibration and direct sunlight.
5. Never put the chemicals directly on the balance pan.
6. Use small brush to remove any chemical, which may have been spilt on the balance.

Lab 4 **First class** **M.s.c Sura Alshmmeri**

Centrifuge It is a device used for separating components of a mixture (two or more substances) from each other by using ***centrifugal force*** .

Centrifugal force is the tendency of an object traveling around a central point to continue in a linear motion and fly away from that central point.

Centrifugation is a mechanical process which involves the use of the centrifugal force to separate particles from a solution depending on the

basis of **their size**, **shape**, **density**, **the viscosity of the medium**, and **the rotor speed**.

principle working of centrifuge :

The centrifuge works using the sedimentation principle, where the dense substance separates out and becomes at the bottom of the tube

Types of centrifuges :

1. Ordinary / Laboratory centrifuge: Are used in chemistry, biology, and biochemistry for isolating and separating solids from liquids in a suspension. The solids can be insoluble compounds, biomolecules, cell organelles, or whole cells.

2. Micro-centrifuge (Hematocrit centrifuge): It uses capillary tubes containing blood to measure the volume of packed cells (PCV) at a speed of about 10,000 rounds per minute (RPM). ❖ Both have a speed not exceeding (10,000-12,000 or 15,000) rounds per minute (RPM). Centrifuge

3. Ultra-centrifuge: Use high centrifugal force for studying the properties of biological particles. Ultra-centrifuges can isolate much smaller particles, including ribosomes, proteins, and viruses. Ultra-centrifuges can also be used in the study of membrane fractionation. This occurs because ultra-centrifuges can reach maximum angular velocities more than 70,000 RPM

4. Refrigerated cent. Cooling is an important added feature to any laboratory centrifuge, with temperature ranges as wide as (-20ºC – - 40ºC), making them perfect for DNA, RNA, PCR, or antibody analysis. Cold centrifuge can obtain rotational speeds of over 30,000 rpm.

Parts of centrifuges:

1-Speedmeter : increasing and decreasing of speed .

2- Timer : control of time .

3- Speed indicator .

4- Head with sample holder .

5- Cover .

6- Electric motor (attached head for carrying sample).

Operation of laboratory centrifuge: Note: The work surface must be level, firm and away from sunlight.

1. Switch at on.

2. Balance the sample that needs to separate with the same amount of water in the same size and quality of tubes. That mean: If you want to run a tube with 10 mL of liquid, put another tube with 10 mL of water in the opposing hole on the rotor. If the liquid has a higher or lower density than water, you must balance the tubes by mass, not volume

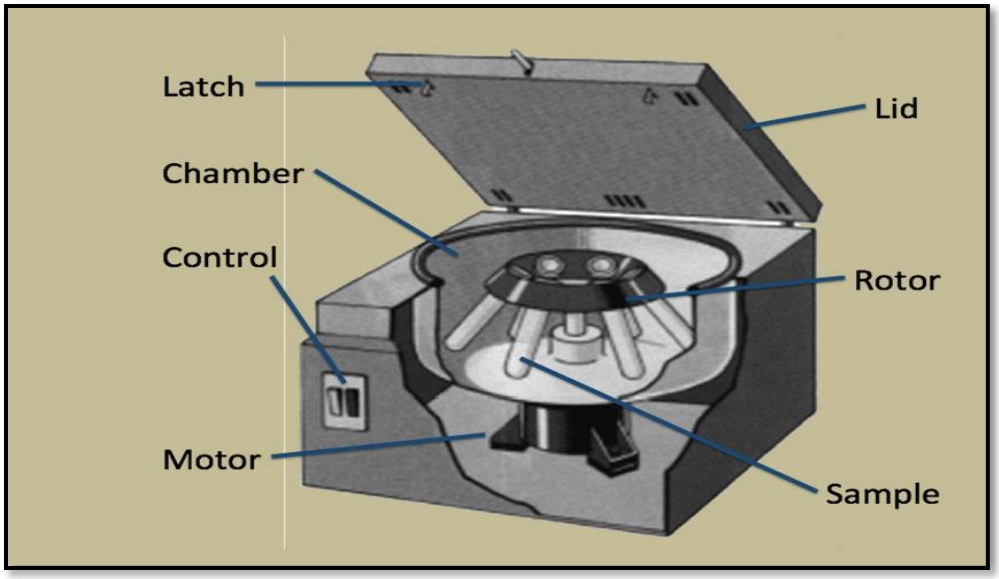
3. Make sure that the test tubes are closed.

4. Open the cover.

5. Put the test tubes in the head as in symmetrical position

6. Close the cover.

7. Choose the time which you need it.



Parts of centrifuge

Uses of Centrifuges:

1- Is used in the separation of a solid material from a liquid.

2- Blood chemistry analyzes to separate serum or plasma from red blood cells.

3- General urinalysis to separate suspended particles in urine.

4- Separation insoluble particles (e.g., insoluble proteins in a protein solution).

5- Separate lipid components .

6- Isotope Separation.

Maintenance of centrifuges

1- Lubricate and clean motor.

2- Clean case.

3- Check lights and indicators.

4- Ensure safety switch is functioning.

5- Ensure temperature reading is working

Lab 5 **First class** **M.s.c Sura ALshmmeri**

Photometer

It is an instrument that measures the strength of electromagnetic radiation in the range from ultraviolet to infrared and including the visible spectrum . Most photometers convert light into an electric current using a photoresistor or photomultiplier . The measurement depending on color filter which give the complement color and in this case the reading less accurate than spectrophotometer which is use monochrometer .

Parts of photometer :

1-**Light source .**

2- **Filter** : to give approximate wave length according to the color .

3-**Sample holder**: which can hold the sample .

4- **Photocell** : it will convert the light to electrical current .

5- **Galvanometer** : which can measure the current from photocell.

6-**Zero adjustment** : which can adjust the zero point and reading .

Types of filter :

1- **Blue filter :** it will pass the wavelength between (400 – 495) nm .

2- **Green filter :** it will pass the wavelength between(500 – 580) nm .

3-**Red filter :** it will pass the wavelength between (600 –800) nm.

Lab 5 **First class** **M.s.c Sura ALshmmeri**

flame photometer

It is an instrument used to determine the concentration of certain metal ions among them sodium, potassium, calcium and lithium. It based on measurement of intensity of the light emitted when a metal is introduced into flame. The wavelength of color determined what the element is (qualitative) and The color's intensity determined how much of the element present (quantitative) .

Parts of flame photometer:

1- Source of flame :A burner provides flame and can be maintained in a constant form and at a constant temperature.

2- Nebulizers and mixing chamber: It helps to transport the homogeneous solution of the substance into the flame at a steady rate.

3- Optical system (optical filter) : It comprises three parts:

A- Convex mirror : It helps to transmit light emitted from the atoms and focus the emissions to the lens.

B- Convex lens :It focus the light on a point called slit. The reflections from the mirror pass through the slit and reach the filters .

C- filter : This will isolate the wavelength to be measured from that of any other extraneous emissions that acts as interference type color filters.

4- Photo detector: Detect the emitted light and measure the intensity of radiation emitted by the flame. The emitted radiation is converted to an electrical signal with the help of photo detector. The produced electrical signals are directly proportional to the intensity of light.

Mechanism of working:

1- The solvent is first evaporated leaving fine divided solid particles.
2- This solid particles move towards the flame, where the gaseous atoms and ions are Produced .
3-The ions absorb the energy from the flame and excited to high energy levels.
4-When atoms return to the ground state radiation of the characteristic element is emitted.
5- The intensity of emitted light is related to the concentration of the element.

flame emissions of the alkali and alkaline earth metals in terms of the emissi on wavelength and the characteristic color produced by each element is shown below :

Elements	**Emitted wavelength range (nm)**	**Observed colour of the flame**
Potassium (K)	766	Violet
Lithium (Li)	670	Red
Calcium (Ca)	622	Orange
Sodium (Na)	589	Yellow
Barium (Ba)	554	Lime green

Applications of Flame photometer:

1- **In agriculture** : the fertilizer requirement of the soil is analyzed by flame test analysis of the soil.

2- **In clinical field** : Determined of Na and K ions in body fluids, muscles and heart can be determined by diluting the blood serum and aspiration into the flame.

3-**Analysis of soft drinks, fruit juices** and alcoholic beverages can also be analyzed by using flame photometry.

Advantages of Flame photometer :

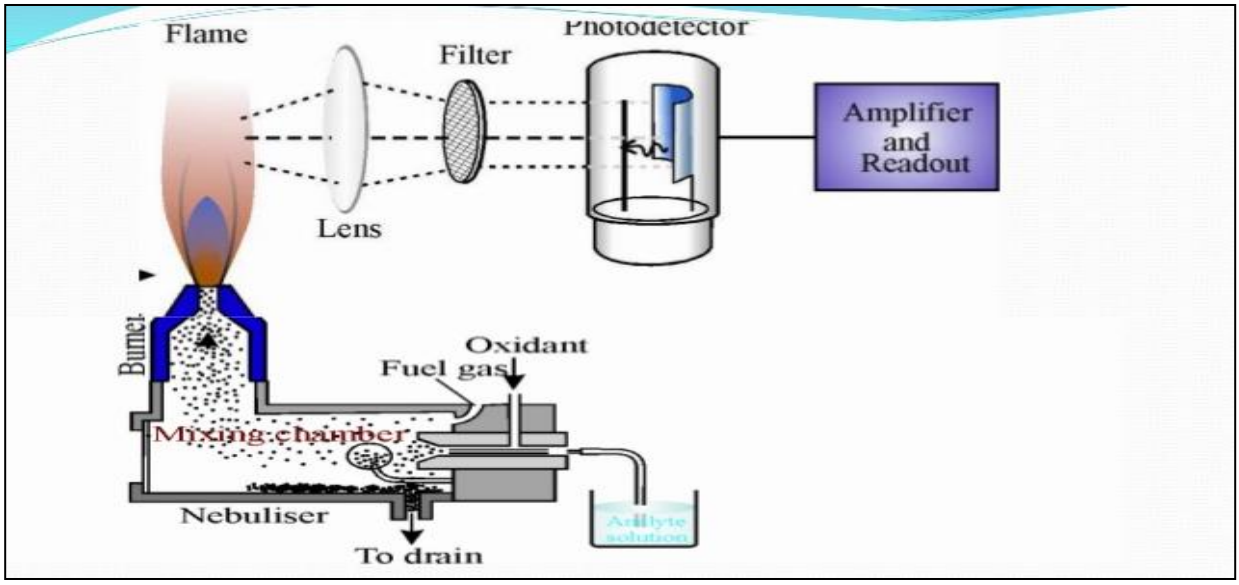
1- The determination of elements such as alkali and alkaline earth metals is performed easily with most reliable and convenient methods.
2- Quite quick and convenient.

Disadvantages of Flame photometer:

1- The concentration of the metal ion in the solution cannot be measured accurately.

2- It is difficult to obtain the accurate results of ions with higher concentration.
3- Cannot be determined the molecular structure of the compound present in the sample solution.

4- The elements such as carbon, hydrogen and halides cannot be detected due to its non-radiating nature.



Various component of a flame

Lab6 **First class** **M.s.c Sura A lshmmeri**

Spectrophotometer

It is an instrument that measures amount of photons (the intensity of light) absorbed after it passes through sample solution , the amount of a known chemical substance (concentrations) can also be determined by measuring the intensity of light detected.

A spectrophotometer consists of two instruments:

A- Spectrometer =light production

B- Photometer = for measuring light intensity .

Types of spectrophotometer depending on the range of wavelength of light source :

- Visible spectrophotometer : uses visible light range (400 - 700 nm) of electro - magnetic radiation spectrum.

- Ultraviolet spectrophotometer (UV) : uses light of ultraviolet range (185 - 400 nm).

- Infrared spectrophotometer (IR) : uses light of infrared range (700 - 15000 nm) of electromagnetic radiation spectrum.

Types of spectrophotometer depending on beam of light :

1- Single Beam spect rophotometer
2- A double beam spectrophotometer
3- Split Beam spectrophotometer

The principle

The basice principle is that each compo uned absorbes or transmits light over acert ain range of wavelength this me asurement can also used to measure the amou nt of a known chemical substance

Parts of spectrophotometer :

1-Light source:

2-Monochromator: It takes light from lamp and splits into different colors

or wavelengths.

3-Wavelength (knob) : to control the certain wavelength applied .

4-Cuvette (with sample) : It is a small square vial that holds the solution with the colored chemical we want to measure (sample). They can be made of glass or plastic. It can hold volumes from 0.1 ml to 5ml.

5-Photodetector : It is a device that can convert light into an electrical signal.

6- Amplifier: the amplifier boosts the electrical signal to increase the sensitivity.
7-Output: Spectrophotometers have a numerical readout to quantify the amount of light that's absorbed as it passes through the sample.
8- Zero point adjustment : it is to set up the equipment to the zero point before use .

Working of Spectrophotometer :
1-Turn the instrument on, allow the instrument warm up for at least 20 minutes.
2-Adjust the wave length to the appropriate value by turning the wave length selector according to the type of sample.
3-Carefully insert the appropriate blank tube (cuvette) that have water or work solution into the sample compartment and close the cover.
(The outside surface of cuvette must be dr y, clean and free from

fingerprints).

4- Press on zero absorbance (0% absorbance) button .

5-Remove the blank cuvette and immediately insert the sample cuvette with solution to be measured in the sample compartment , read absorbance value of the sample.

6- Record the absorbance value of the sample.

Applications of Spectrophotometer :

1. Concentration measurement .
2. Detection of impurities .
3. Chemical kinetics .
4. Detection of functional group .
5. Molecular weight determination.

Lab7 First class M.s.c Sura Alshmmeri

Autoclave

autoclave is devices that are used for sterilization of medical devices under high pressure and temperatures., its provides a physical method of sterilization that killing bacteria, viruses, and even spores present in the material using steam under pressur

Sterilization is process whereby microorganisms of all kinds are inactivated, killed, or removed from materials medical materials, and it is crucial for human health

Types of sterilization :

A- Dry sterilization .

B- Moist heat sterilization.

Mechanism of Killing the microorganisms by hot water or steam :

Divided into three forms in terms of temperature:

1. Temperature below 100°C (Pasteurization method) .
2. Temperature at 100°C (Tyndallization method) .
3. Temperature above 100°C (Autoclaving method) .

Types of autoclaves:

1-**Heat autoclaves:** It is the most common source for autoclaving heating There are two types :

A- Dry heat autoclave.

B- Steam heat autoclave .

2- **Gas autoclaves :** used a vapor solution to sterilize its contents , formaldehyde gas and ethylene oxide are the sterilizing agents used in gas autoclaves.

3- Ultraviolet autoclaves : They produce ultraviolet light that kill the unwanted organisms causing disease.

Principle

Water usually boils at 100°C under normal atmospheric pressure the boiling point of water increases if the pressure is to be The high pressure increases the boiling point of water and thus helps achieve a higher temperature for sterilization.

2-This principle is employed in an autoclave where the water boils at 121°C at the pressure of 15 psi or 775 mm of Hg.

Parts of the Autoclave:

1-External form : It's made from aluminum or stainless steel

2.Pressure Chamber

3.Lid/ Door

4.Pressure gauge

5.Pressure releasing unit

6.Safety valve

7.Steam generator/ Electrical heater

Autoclave device

Method of operation:

1- Fill the bottom of autoclave with distilled water, but below the basket bottom.

2- Place the articles within the basket.

3- Close the lid and tighten the screws.

4- Adjust the temperature, pressure and time.

5- Upon completion of the sterilization time discards steam by opening the valve for that then opens the lid.

Uses of Autoclave :

Autoclaves are used to sterilized the following :

1. Culture media
2. Surgical instruments
3. Solutions and water
4. Bio hazardous waste
5. Glassware

Maintenance of Autoclaves

Daily : - Clean Door Seal .

- Clean the External Surface .

Weekly : - Clean Distilled Water Reservoir .

- Clean Sterilization Chamber .

Monthly : Clean Filter inside Chamber and Tank

Lab8

Microtome is a mechanical instrument used to cut biological specimens into very thin segments for microscopic examination.

Micro = Small, Tome = Cut.

Biological specimens can be presented in many ways. But more often, these specimens are embedded in paraffin wax blocks and the commonest way of sectioning these specimens can be achieved by the microtome

Types of Microtome :

There are several types of microtome each designed for a specific purpose , there are basic types of microtome are named according to the machine as following :

1-Rotary microtome : It is an excellent machine for research and is valuable for the preparation of serial section .

2-Freezing microtome: It is using for cutting section when :

1- It is required to demonstrate fat histological.

2- Neurological structure are to be studies.

3-Ultra microtome.

4-Laser microtome.

5- Saw microtome : It is used for hard material such as teeth or bones.

6-Vibrating microtome : It used for difficult biological samples .

7- Sledge microtome .

Parts of microtome :

1- Body with cover .

2- Operating handle with brake .

3- Knife .

4- Angle of tilt adjustment .

5- Base with knife carrier .

6- Knife clamps with screw .

7- Micron adjustment with thickness gauge .

8- Coarse adjustment of micron .

Types of microtome knife:

A- Knives are classified according to their shape when viewed in profile as following :

1- Plano wedges :Used for cutting all types of section on any microtome .

2- Plano concave :Used for nitrocellulose embedded tissues .

3- Semi Plano concave .

4- Biconcave : It is Less rigid , prone to more vibrations with gradual adoption of more substantial microtome .

5- Tool edge (D – profile) : It is also called " chisel edge " used to section hard tissue , decalcified cortical bone, undecalcified bone .

B- Types of knives according to material that made of :

Microtomes use steel, glass, or diamond blades depending upon the specimen being sliced and the desired thickness of the sections being cut.

Advantages

1. The machine is heavy, so it is stable and does not vibrate during cutting.
2. Serial sections can be obtained.

3. Cutting angle and knife angle can be adjusted.

4. Paraffin-embedded tissues are cut by a rotary microtome.

5. The knife holder is movable.

6. The sections are cut are flat.

7. It is useful for routine and research papers

Rotary Microtome Main Applications

●For observing the morphological structure of normal cellular tissues of plants and animals ●For studying, observing and determining the morphological changes of cellular tissues

●For immunohistochemistry, immunofluorescence, genome sequencing, etc

Maintenance of microtomes:

1-Keep it clean from paraffin .

2- The sharpening of the knife is the main maintenance of microtomes .

Lab9

Introduction

Electrophoresis is a widely used laboratory technique that separates charged molecules based on their size, charge, and movement in an electric field. It is commonly used in biochemistry, molecular biology, and clinical laboratories to analyze DNA, RNA, and proteins.

When an electric current is applied, charged particles migrate toward the electrode with the opposite charge. Positively charged molecules move toward the cathode, while negatively charged molecules move toward the anode.

Principle of Electrophoresis

The basic principle of electrophoresis depends on the movement of charged particles in an electric field. The rate of movement (migration) of molecules is influenced by:

- The **electric field strength**
- The **charge of the molecule**
- The **size and shape of the molecule**
- The **type of supporting medium** (gel)
- The **buffer solution**

Smaller molecules move faster through the gel matrix than larger molecules.

Types of Electrophoresis

1. Agarose Gel Electrophoresis

- Used mainly for **DNA and RNA** separation
- Agarose gel acts as a porous matrix
- Commonly used in genetic analysis and molecular biology

2. Polyacrylamide Gel Electrophoresis (PAGE)

- Used for **proteins and small DNA fragments**
- Provides high resolution
- Includes SDS-PAGE for protein analysis

3. Capillary Electrophoresis

- Uses narrow capillaries instead of gels
- High speed and high sensitivity
- Common in clinical and pharmaceutical analysis

4. Paper Electrophoresis

- Uses filter paper as a supporting medium
- Mainly used for amino acids and small molecules

Main Components of Electrophoresis Apparatus

1. Power supply
2. Electrophoresis chamber (tank)
3. Gel tray and comb
4. Electrodes (anode and cathode)

5. Buffer solution
6. Supporting medium (agarose or polyacrylamide gel)

Steps of Electrophoresis Procedure

1. Prepare the gel and allow it to solidify
2. Place the gel in the electrophoresis chamber
3. Add buffer solution
4. Load samples into the wells
5. Apply electric current
6. Allow samples to migrate
7. Visualize the results using staining or UV light

Applications of Electrophoresis

1. DNA fingerprinting
2. Genetic testing
3. Protein analysis
4. Diagnosis of diseases
5. Forensic investigations
6. Research in molecular biology

Advantages of Electrophoresis

- High accuracy
- Simple and cost-effective

- Requires small sample volume
- Widely applicable in research and diagnostics

Safety Precautions

- Wear gloves and lab coat
- Handle electrical equipment carefully
- Avoid direct contact with buffer solutions
- Use UV protection when visualizing gels

Lab10

introduction

Water purification is a critical process in laboratory and medical environments to ensure the removal of impurities that may interfere with experimental results. Purified water is essential for chemical reactions, solution preparation, washing glassware, and operating sensitive laboratory instruments.

Two common laboratory water purification systems are **distillators** and **deionizers**.

Importance of Purified Water in Laboratories

- Prevents contamination of samples
- Ensures accuracy and reliability of results

- Protects laboratory instruments from damage
- Essential for biochemical, clinical, and analytical procedures

Water Impurities

Water may contain:

- Dissolved salts (ions)
- Organic compounds
- Microorganisms
- Particulate matter
- Gases

Purification systems are designed to remove these contaminants.

1. Distilled Water and Distillators

Definition

Distilled water is water that has been purified by **distillation**, a process involving boiling water and condensing the steam into liquid form.

Principle of Distillation

Distillation works on the principle that:

- Water vaporizes when heated
- Most impurities do not evaporate

- The vapor is condensed to produce pure water

Parts of a Distillator

1. Heating element
2. Boiling chamber
3. Condenser
4. Cooling system
5. Collection container

Working of a Distillator

1. Water is heated until it boils
2. Steam rises, leaving impurities behind
3. Steam passes through a condenser
4. Steam cools and condenses into liquid water
5. Distilled water is collected in a clean container

Advantages of Distilled Water

- Free from most salts and microorganisms
- High purity
- Suitable for many laboratory applications

Disadvantages

- High energy consumption
- Slow process
- Does not remove volatile organic compounds completely

2. Deionized Water and Deionizers

Definition

Deionized water is water that has had **its mineral ions removed** using ion-exchange resins.

Principle of Deionization

Deionization is based on **ion exchange**, where:

- Positive ions (cations) are replaced with hydrogen ions (H^+)
- Negative ions (anions) are replaced with hydroxide ions (OH^-)
- H^+ and OH^- combine to form pure water (H_2O

Types of Ion Exchange Resins

1. **Cation exchange resin** – removes Ca^{2+}, Mg^{2+}, Na^+
2. **Anion exchange resin** – removes Cl^-, SO_4^{2-}, NO_3^-

Working of a Deionizer

1. Water passes through cation resin
2. Positive ions are removed
3. Water passes through anion resin
4. Negative ions are removed
5. Deionized water is collected

Advantages of Deionized Water

- Very low ionic content
- Fast process
- No heating required
- Cost-effective for large volumes

Disadvantages

- Does not remove microorganisms or organic compounds
- Resins require regeneration or replacement

Comparison Between Distilled and Deionized Water

Feature	Distilled Water	Deionized Water
Method	Boiling & condensation	Ion exchange
Removes ions	Yes	Yes
Removes microbes	Yes	No

Feature	Distilled Water	Deionized Water
Energy required	High	Low
Speed	Slow	Fast
Cost	Higher	Lower

Applications

- Preparation of reagents and solutions
- Washing laboratory glassware
- Clinical laboratory tests
- Pharmaceutical and chemical industries
- Autoclaves and analytical instruments

Safety and Maintenance

- Regular cleaning of distillators
- Monitoring resin life in deionizers
- Using clean storage containers
- Avoid contamination after purification