

PROFESSIONAL TRAINING - I

Submitted in partial fulfilment of the requirements for the award of
Bachelor of Technology degree in Biomedical Engineering

By

RANJITH B (41240028)



**DEPARTMENT OF BIOMEDICAL ENGINEERING
SCHOOL OF BIO AND CHEMICAL ENGINEERING**

**SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited with Grade “A++” by NAAC
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119.**



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DEPARTMENT OF BIO AND CHEMICAL SCIENCES

BONAFIDE CERTIFICATE

This is to certify that this Professional Training Report is the bonafide work of **RANJITH B(41240028)** who has completed the training program in "PROFESSIONAL TRAINING ON EXPLORING TOOLS AND TECHNIQUES FOR DRUG DISCOVERY" as a part of professional development under my supervision from 20/09/2023 to 23/09/2023.

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Exploring Bioanalytical Tools and Techniques for Drug Discovery

CERTIFICATE

This is to certify that Ranjith B has attended the Training session on “**Exploring Bioanalytical Tools and Techniques for Drug Discovery**” from 20th to 25th September 2023 jointly organized by the Department of Biomedical Engineering and Centre for Drug Discovery and Development, Sathyabama Institute of Science and Technology.

Dr. Krupakar Parthasarathy
Convener

Dr. T. Sudhakar
Convener

Dr. M. Radhakrishnan
Centre In-charge

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DECLARATION

I **RANJITH B** hereby declare that the professional training Report completed by me during my professional training at “**SATHYABAMA CENTER FOR DRUG DISCOVERY AND DEVELOPMENT**” under the guidance of **Dr.A.SABARIVANI, M.Tech.,PhD.,** and **Ms.SINDU DIVAKARAN** is submitted in partial fulfillment of the requirements for the award of Degree in Bachelor of Technology in Biomedical Engineering 2021-2025.

DATE: 03.10.2023

PLACE: CHENNAI


SIGNATURE OF THE CANDIDATE

RANJITH B

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ABSTRACT

In the rapidly advancing field of pharmaceuticals and life sciences, my recent professional training in **Bioanalytical tools and drug discovery** has provided me with invaluable insights and skills. This report offers a glimpse into the essential concepts and techniques I've learned during this training, highlighting their significance in advancing the world of drug development.

Throughout this report, we will explore the role of bioanalytical tools in understanding biological processes, identifying potential drug candidates, and ultimately improving healthcare outcomes. This training has not only expanded my knowledge but also deepened my appreciation for the critical role these tools play in shaping the future of medicine.

Join me as we embark on this journey through the world of bioanalytical tools and their vital contribution to the field of drug discovery.

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I. INTRODUCTION

Bioanalytical tools are nothing short of a scientific revolution in the realm of drug discovery, reshaping our understanding of pharmaceuticals and propelling innovation to unprecedented heights. This report embarks on a journey to unveil the inner workings, essential principles, and the profound implications of these tools. As we delve into this exploration, we will illuminate their pivotal role in not only accelerating drug discovery but also elevating precision in pharmaceutical research.

Beyond the celebration of their transformative impact, we confront the very real challenges that accompany the deployment of bioanalytical tools. From the complexities of data integration to the stringent demands of regulatory compliance, these are hurdles we must navigate on our path to harnessing the full potential of these instruments.

In an era characterized by artificial intelligence and advanced analytics, we glimpse the extraordinary possibilities that lie ahead, promising even greater precision, efficiency, and efficacy in drug development.

This report emphasizes the crucial need to keep investing in bioanalytical tools. These tools are like the foundation of healthcare progress, and they help us make patients healthier.

As we go forward, we'll look closely at different bioanalytical tools. We'll see what they can do, where they're used, and how they play a vital role in finding new medicines.

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1.2. DRUG DISCOVERY

Scientists search for special molecules that can unlock solutions to health problems. This process is called drug discovery, and it's like a treasure hunt for medicines.

1. **Finding the Target:** First, scientists identify the "bad guys" in our bodies, like proteins that cause diseases. These "bad guys" become the target for the medicine.
2. **Searching for Hits:** Scientists then look for tiny substances that might stop the "bad guys" (targets). It's like finding clues on the treasure map. They test many substances to see if any of them can do the job.
3. **Making the Hit Stronger:** Once they find something that works a little, they try to make it even better. It's like turning a small clue into a big one on the treasure map.
4. **Safety Tests:** Before giving the medicine to people, scientists check if it's safe. They use lab tests and experiments on animals to make sure it won't harm anyone.
5. **People Tests:** If everything looks good, they try the medicine on real people in a series of tests. They check if it works well and if there are any side effects.
6. **Approval and Monitoring:** If the medicine passes all the tests, it gets permission to be used. But even after that, they keep an eye on it to make sure it's safe for everyone.

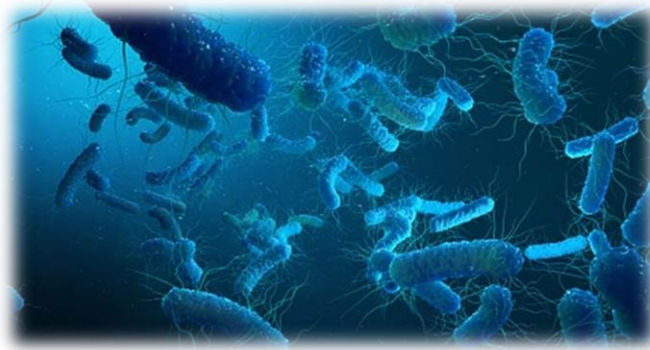
Throughout this process, scientists use special tools to understand the medicines better. These tools help them figure out which substances might work, how to make them stronger, and whether they're safe to use.

1.3. BACTERIAL CULTURING

Bacterial culturing is like creating a home for very tiny living things called bacteria. Bacteria are so small we can't see them without a microscope, but they are all around us, some are good, and some can make us sick. Scientists use bacterial culturing to study and control these tiny creatures.

STEPS THEY FOLLOW :

1. **Getting the Bacteria:** First, scientists need to get the bacteria they want to study. They might take a tiny bit of bacteria from somewhere, like your skin or a dirty surface.

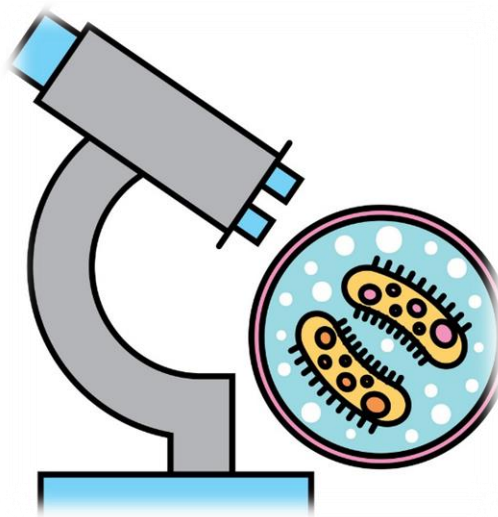


2. **Making the Perfect Home:** Bacteria need a good place to live and grow. So scientists make a special "home" for them in a container with nutrients like food, water, and the right temperature. It's like creating a comfy environment for them to thrive.



3. Feeding and Growing: Bacteria eat the nutrients in their new home and start multiplying. This means one bacterium becomes two, two become four, and so on. It's like a bacteria party where they invite more and more guests

4. Studying and Using: Once scientists have lots of bacteria, they can study them to learn how they behave or to make useful things. For example, bacteria can be used to make medicines or to clean up pollution.



5. Keeping It Clean: Scientists have to be careful to keep everything clean and free from other bacteria or germs that could spoil the culture. They wear special clothes and use special equipment to keep the bacteria safe.

Bacterial culturing is an important tool in biology and medicine. It helps scientists understand bacteria better and use them for different purposes, from making yogurt to creating vaccines. It's like creating a little world where bacteria can grow and do their thing so we can learn from them and use their powers for good!

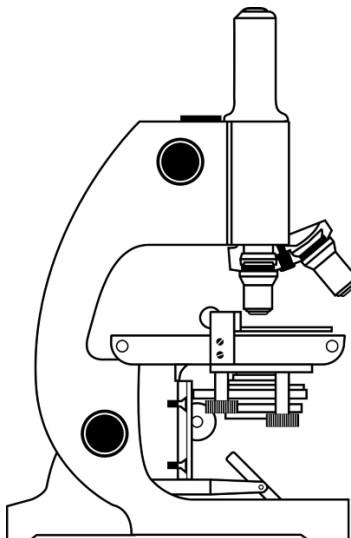
INSTRUMENTS

2.1. MICROSCOPE

The microscope is an essential tool in the world of science and research, allowing us to peer into the tiny and uncover the mysteries of the microscopic world.

Key Components of a Microscope

1. **Objective Lens:** The objective lens is the lower lens of the microscope, positioned just above the specimen. It gathers light and magnifies the image.
2. **Eyepiece (Ocular Lens):** The eyepiece is the upper lens you look through. It further magnifies the image produced by the objective lens.
3. **Stage:** The stage is where you place the specimen or slide you want to examine.
4. **Illumination Source:** In optical microscopes, a light source, often located beneath the stage, shines light through the specimen to make it visible.
5. **Focusing Knobs:** Focusing knobs allow you to sharpen the image by adjusting the distance between the lenses and the specimen.



Applications Across Diverse Fields

Microscopes find applications in a wide range of scientific disciplines:

1. **Biology:** Microscopes are indispensable for studying cells, tissues, and microorganisms, aiding in the understanding of life processes.
2. **Medicine:** In healthcare, they help diagnose diseases, examine tissues, and analyze blood samples.
3. **Material Science:** Microscopes aid in analyzing materials at the atomic and molecular levels, facilitating advancements in technology and manufacturing.
4. **Environmental Science:** They are used to study environmental samples, such as soil and water, to monitor and protect ecosystems.
5. **Forensics:** Microscopes play a critical role in forensic investigations, helping to analyze evidence and solve crimes.

2.2. EPPENDORF CENTRIFUGE

Eppendorf centrifuges are reliable laboratory devices used for separating materials in samples by spinning them at high speeds. They come in various types, like microcentrifuges and tabletop centrifuges

- High-speed centrifuge for separating particles in biological samples.
- Uses centrifugal force to isolate cells, organelles, proteins, and nucleic acids.
- Essential in DNA extraction, protein purification, and cellular fractionation.
- Offers multiple rotor options for different sample types and volumes.
- Precise temperature control for maintaining sample integrity.
- Used in pharmaceutical research for drug formulation and biomarker discovery.
- Benchtop design for easy access in laboratories.
- A versatile tool for a wide range of bioanalytical applications.



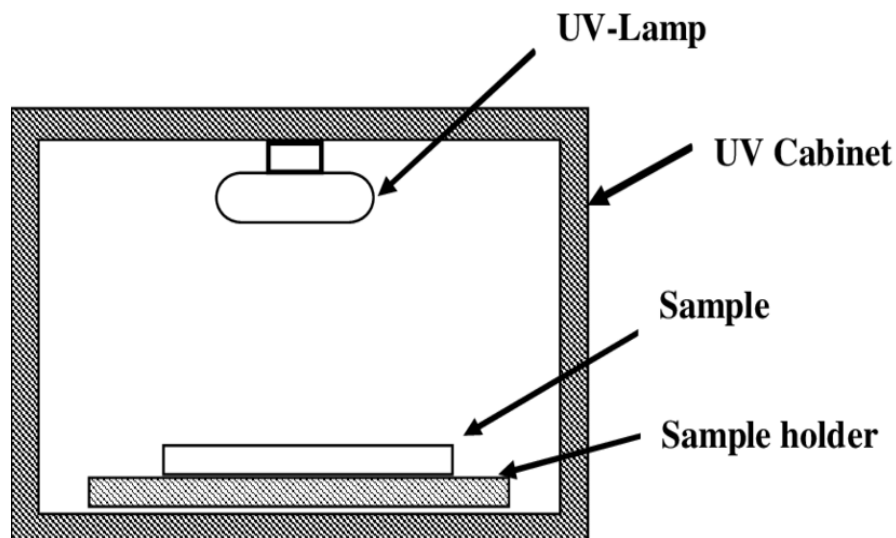
2.3. UV CHAMBER

Ultraviolet Chamber:

A UV chamber is a machine that uses ultraviolet (UV) light to clean and sterilize things. It's like a special box with UV lights inside. When you put things inside and turn on the UV light, it kills germs and makes the items clean and safe to use. UV chambers are used in labs and hospitals to keep things sterile.

USES:

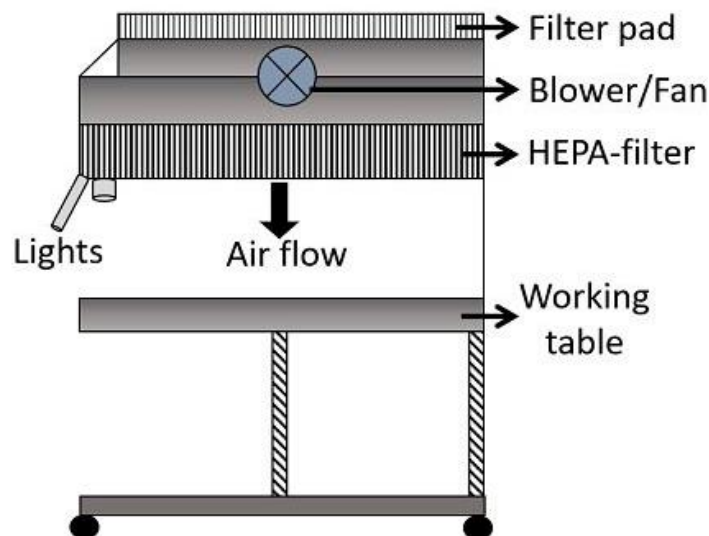
- Sterilization chamber equipped with UV light.
- Kills or inactivates microorganisms, preventing contamination.
- Used for sterilizing equipment, glassware, and lab surfaces.
- Ensures aseptic conditions in microbiology and molecular biology experiments.
- Important for bacterial culture work and PCR setup.
- Maintains a sterile environment critical for reliable results.



2.4. LAMINAR AIR FLOW:

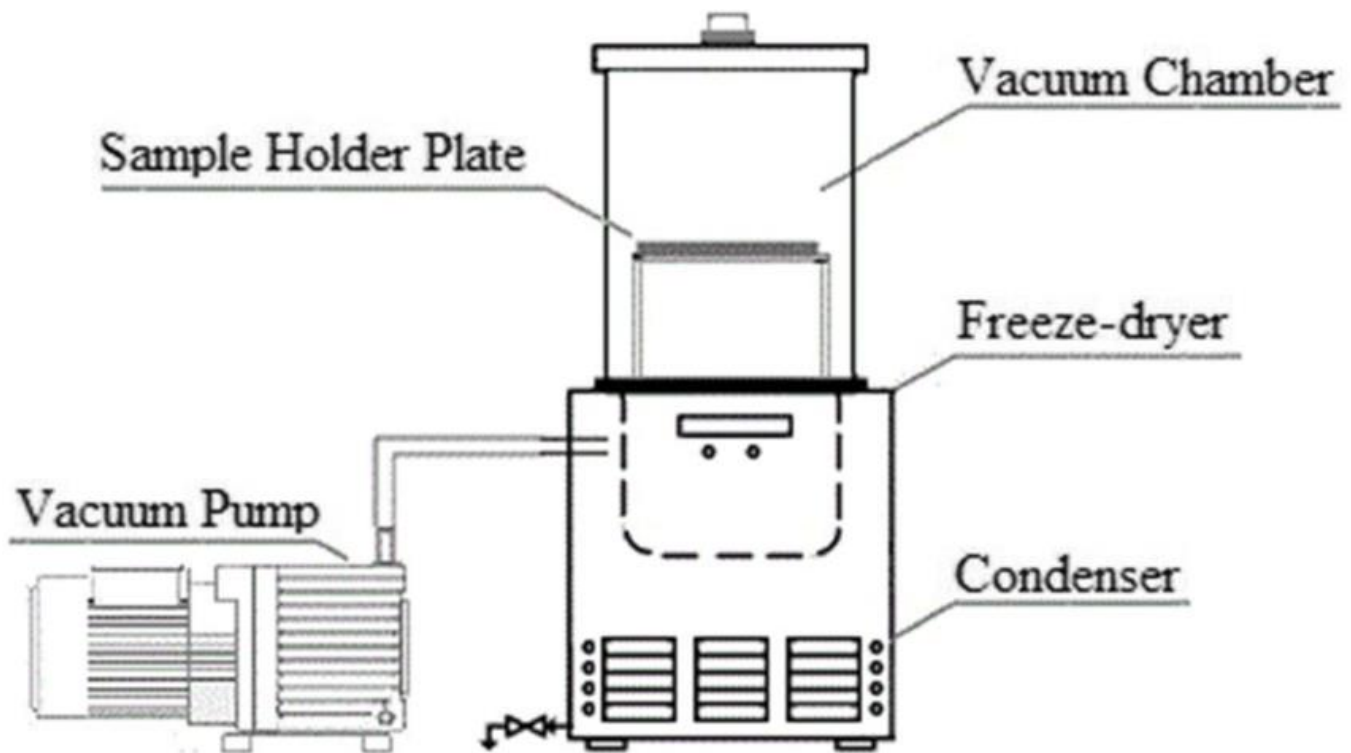
A laminar airflow cabinet is like a clean and sterile workspace for scientists and medical professionals. It has a special filter that makes the air inside very clean. The air flows in a smooth and even way, like a gentle breeze, to keep the work area free from dust and germs. This helps with tasks like growing cells or working with sensitive materials without contamination. Laminar airflow cabinets are used in labs and hospitals to keep things clean and safe.

- Enclosed workspace with a controlled laminar airflow.
- Provides a sterile environment for sensitive work.
- Commonly used in microbiology, tissue culture, and drug formulation.
- Prevents airborne contamination during experiments.
- Vertical and horizontal laminar flow cabinets available.
- HEPA or ULPA filters ensure clean air circulation.
- Equipped with UV lamps for added sterilization.
- Enables aseptic techniques and safe handling of samples.



2.5. FREEZE DRYER

FREEZE DRYER are used for Preserving Biomaterials with Precision

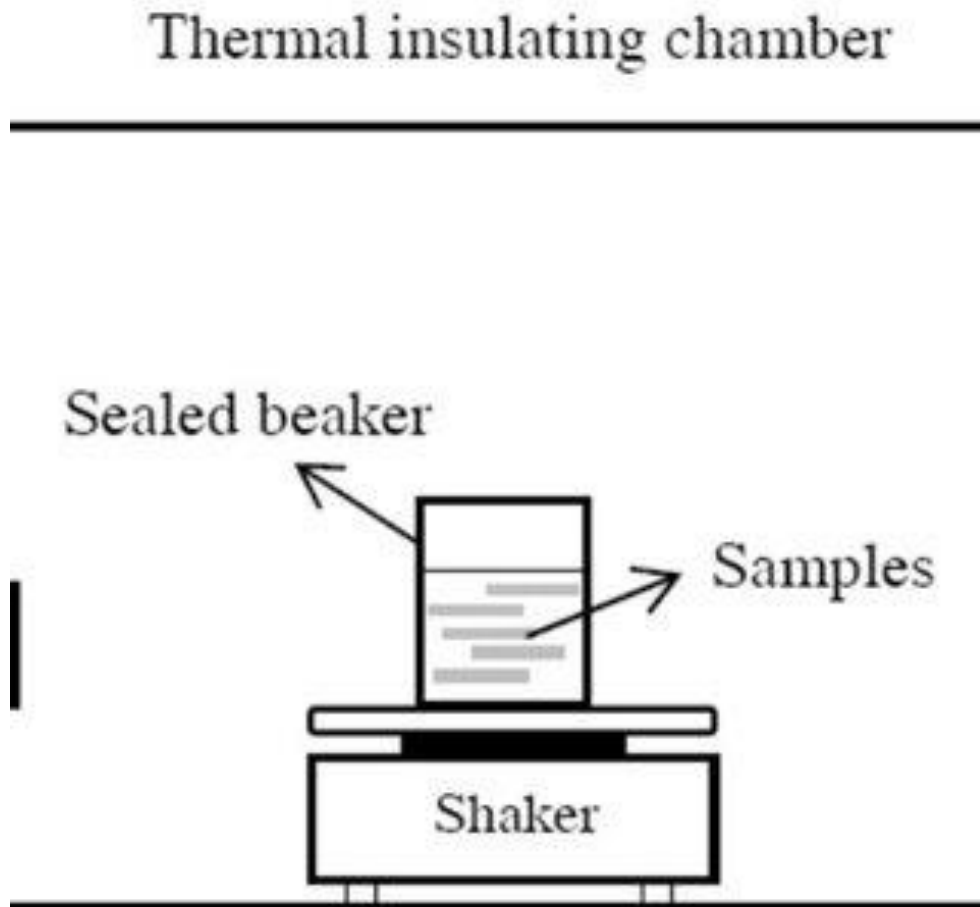


- **Purpose:** Freeze dryers, also known as lyophilizers, are vital instruments used in biotechnology and pharmaceuticals to remove moisture from various materials while preserving their structure and properties.
- **Process:** The freeze-drying process involves freezing the material, creating a vacuum, and then slowly raising the temperature. This sublimates the frozen water directly from ice to vapor, leaving behind a dry product.

- **Applications:** Freeze dryers are crucial for preserving sensitive biological materials like proteins, enzymes, vaccines, and pharmaceuticals ,preserving fruits, and creating powdered products.
- **Advantages:.**
 - Prolongs the shelf life of products by removing moisture, preventing spoilage.
 - Facilitates easy storage and transportation of materials in a lightweight, dry form.
- **Importance:** Freeze dryers are indispensable in research, pharmaceutical manufacturing, and food production, ensuring the stability and longevity of valuable products and biological specimens.

2.6. SHAKING INCUBATOR

Shaking Incubator are used to maintain Precision and Consistency in Cell and Microbial Cultures

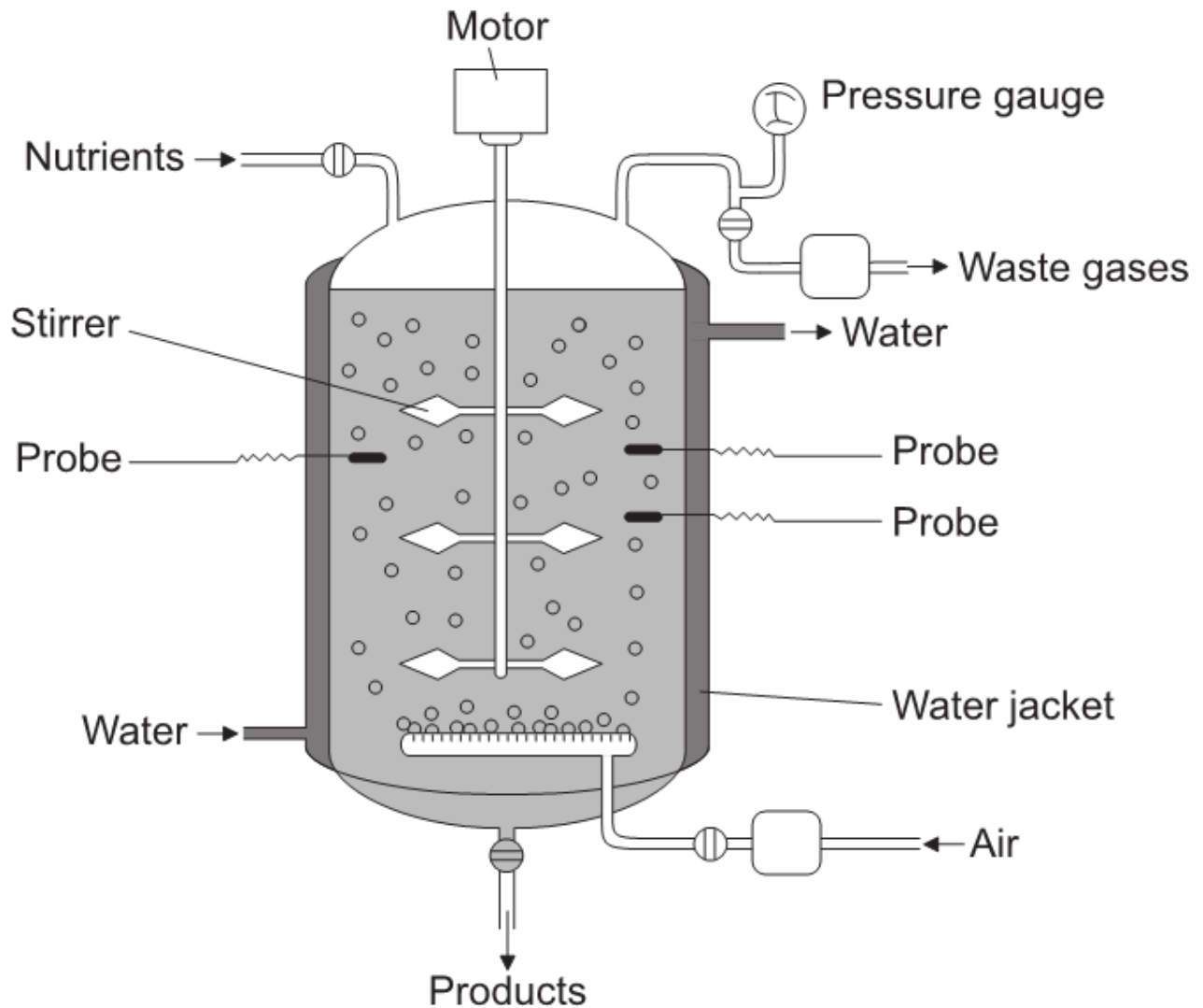


- **Purpose:** A shaking incubator is a laboratory device designed to provide controlled temperature conditions while agitating the contents of a flask or container. It is primarily used for the cultivation of cell cultures and microbial organisms.
- **Process:** Shaking incubators combine controlled temperature with continuous agitation, usually via orbital or linear shaking motions. This ensures even distribution of nutrients and oxygen in the cultures, promoting optimal growth.

- **Applications:** Shaking incubators are indispensable in various fields, including microbiology, biotechnology, and pharmaceutical research. They support the growth of cells for applications like protein expression, fermentation, and drug development.
- **Advantages:**
 - Maintains consistent temperature and agitation, essential for reproducible results.
 - Provides a controlled environment for a wide range of organisms.
 - Allows researchers to conduct experiments requiring continuous growth and monitoring.
- **Importance:** Shaking incubators play a crucial role in scientific research, enabling the controlled growth of microorganisms and cells. They are essential tools for bioprocessing, drug discovery, and the study of cellular behavior, contributing to advancements in medicine and biotechnology.

2.7. FERMENTOR

Fermentors are used for cultivating microorganisms for bioprocessing.



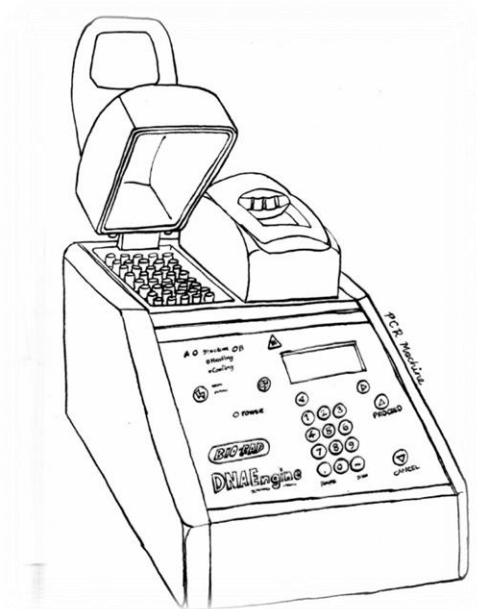
- **Purpose:** A fermentor, also known as a bioreactor, is a specialized vessel used in biotechnology and industrial microbiology to cultivate microorganisms, such as bacteria, yeast, or fungi, under controlled conditions.

- **Process:** The fermentor provides an optimal environment for microorganism growth by regulating factors like temperature, pH, oxygen level, and nutrient supply. It allows for the controlled fermentation or bioprocessing of substances.
- **Applications:** Fermentors are critical in various industries, including pharmaceuticals, food and beverage, and biofuels. They are used to produce antibiotics, vaccines, enzymes, bio-based products, and biofuels through microbial fermentation.
- **Advantages:**
 - Precise control over growth conditions ensures consistent product quality.
 - Scalable from small laboratory setups to large industrial systems.
 - Allows for the production of valuable biological products and bioactive compounds.
- **Importance:** Fermentors are essential tools in bioprocessing, enabling the large-scale production of biologically derived substances with applications in healthcare, energy, and agriculture. They contribute significantly to the development of sustainable and innovative products.

2.8. PCR

PCR (Polymerase Chain Reaction)

PCR are used for the Amplification of Genetic Code



- **Purpose:** PCR machines are laboratory instruments designed to perform Polymerase Chain Reactions. They are used to amplify specific DNA sequences, creating millions of copies from a small DNA sample.
- **Process:** PCR machines automate the temperature cycling required for PCR. They control heating and cooling cycles to denature, anneal, and extend DNA strands. A DNA polymerase enzyme catalyzes the DNA replication process.

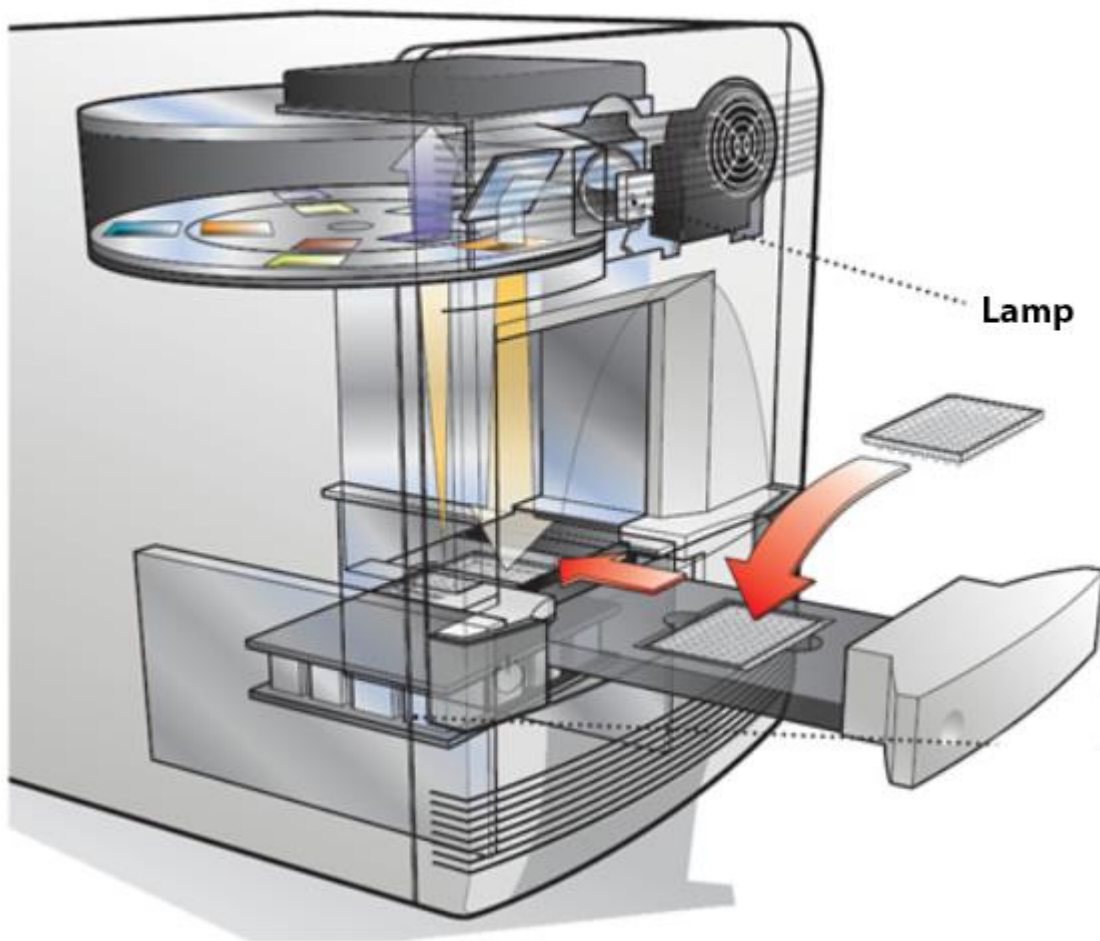
- **Applications:** PCR machines have diverse applications in genetics, diagnostics, and research. They are pivotal in DNA profiling, genetic testing, disease diagnosis, and gene cloning.
- **Advantages:**
 - Precision: PCR machines ensure accurate temperature control for consistent results.
 - Sensitivity: They can detect and amplify even trace amounts of DNA.
 - Speed: PCR machines accelerate DNA amplification, saving time in the laboratory.
- **Importance:** PCR machines have revolutionized molecular biology, enabling researchers to study genes, diagnose genetic disorders, and understand diseases at the molecular level. They are indispensable in modern genetics and diagnostics.

2.9. RT-PCR

RT-PCR (Reverse Transcription PCR)

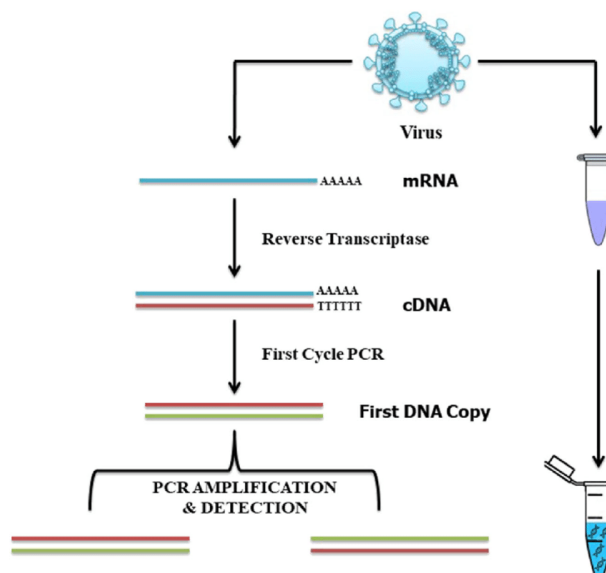
Used for Unraveling RNA's Secrets

Real Time PCR Machine



- **Purpose:** RT-PCR machines are specialized instruments used for Reverse Transcription Polymerase Chain Reactions. They amplify RNA sequences, converting them into complementary DNA (cDNA) for further analysis.

- **Process:** RT-PCR combines reverse transcription (converting RNA to cDNA) with traditional PCR amplification. It allows for the study of gene expression by measuring mRNA levels.
- **Applications:** RT-PCR machines are essential in gene expression analysis, studying RNA viruses, and diagnosing diseases. They play a pivotal role in understanding how genes are expressed and regulated.
- **Advantages:**
 - Insight into Gene Expression: RT-PCR provides valuable data on the activity of specific genes.
 - Disease Diagnosis: It's used to detect RNA viruses like SARS-CoV-2 (COVID-19).
 - Drug Development: RT-PCR informs the development of therapies that target gene expression.
- **Importance:** RT-PCR machines are fundamental tools in molecular biology, enabling researchers and healthcare professionals to explore gene expression patterns, diagnose diseases, and develop targeted therapies. They bridge the gap between RNA analysis and genetic insights.



NEW EXPLORATION

3.1. BIOFOULING

Biofouling refers to the unwanted accumulation of marine organisms on submerged surfaces, such as ship hulls, underwater infrastructure, and marine equipment. This phenomenon occurs due to the rapid colonization of surfaces by various microorganisms, algae, mollusks, and other aquatic species. Biofouling poses significant challenges to industries like shipping, aquaculture, and offshore energy production for several reasons:

1. **Increased Drag and Fuel Consumption:** Biofouling increases hydrodynamic drag on ship hulls, leading to increased fuel consumption and reduced operational efficiency. This translates into higher operating costs and environmental impacts.
2. **Corrosion and Structural Damage:** The growth of biofouling organisms can corrode and damage underwater structures, leading to costly maintenance and repairs.
3. **Ecological Impact:** Biofouling species can be invasive and disrupt local ecosystems by outcompeting native species or introducing non-native organisms.



Recent Research in Antifouling Paints

In response to the challenges posed by biofouling, researchers and industries have been actively developing and studying antifouling paints and coatings. These specialized coatings are designed to prevent or reduce the attachment and growth of marine organisms on submerged surfaces. Recent research in this field has yielded innovative approaches:

1. **Environmentally Friendly Formulations:** Researchers are focusing on the development of environmentally friendly antifouling paints. These formulations aim to minimize the release of harmful chemicals into the marine environment, aligning with sustainability goals.
2. **Microtexture and Nanotechnology:** Advancements in microtexture and nanotechnology have led to the creation of coatings with intricate surface structures that discourage biofouling organisms from adhering to surfaces.
3. **Bioactive Compounds:** Antifouling paints now incorporate bioactive compounds, such as natural extracts or synthetic molecules, which deter the attachment and growth of marine organisms.
4. **Biocidal Alternatives:** Researchers are exploring non-biocidal alternatives that prevent fouling through physical and mechanical means, reducing the environmental impact.
5. **Long-Term Efficacy:** Ongoing research aims to improve the long-term effectiveness of antifouling coatings, ensuring they remain operational for extended periods without the need for frequent reapplication.

3.2. CHROMATORGRAPHY

Chromatography is a versatile analytical technique used to separate and identify the components of complex mixtures. It relies on the differential interaction between the sample molecules and a stationary phase within a column, resulting in distinct separation based on various properties. Chromatography finds wide applications in chemistry, biology, pharmaceuticals, food science, environmental analysis, and more.

Principles of Chromatography:

1. **Stationary Phase:** Chromatography involves a stationary phase, often a solid or liquid material packed into a column, and a mobile phase, which carries the sample through the column.
2. **Separation Mechanism:** Components in the sample interact differently with the stationary phase. Some components will bind strongly and move slowly, while others will bind weakly and move quickly.
3. **Detection:** As the separated components exit the column, they can be detected and quantified using various methods, such as UV-Vis spectroscopy, fluorescence, or mass spectrometry.
4. **Types:** There are several chromatographic techniques, including gas chromatography (GC), liquid chromatography (LC), high-performance liquid chromatography (HPLC), and thin-layer chromatography (TLC), each tailored to specific applications.

In conclusion, chromatography is a powerful analytical tool that plays a major role in diverse scientific disciplines. The choice of chromatographic technique and instrument depends on the specific application and the nature of the compounds being analyzed. These instruments contribute significantly to research, quality control, and the advancement of scientific knowledge across various fields.

4. CONCLUSION

In conclusion, bioanalytical tools have revolutionized drug discovery by providing precise data for the development of new medicines. These tools, ranging from mass spectrometry to high-throughput screening, expedite the identification of promising drug candidates. Integration with computational and AI-driven methods further accelerates drug development. As personalized medicine gains traction, bioanalytical tools facilitate tailored treatments and biomarker discovery.

However, navigating regulatory requirements and ensuring ethical considerations remain paramount. Continued innovation in analytical techniques holds the potential to address complex diseases and improve healthcare. In this dynamic field, interdisciplinary collaboration among researchers, clinicians, and regulatory agencies will be key to harnessing bioanalytical tools for safer and more effective medications.

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