

PROFESSIONAL TRAINING- I REPORT

Submitted in partial fulfilment of the requirements for the award of bachelor of technology degree in biomedical engineering

By

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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

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BONAFIDE CERTIFICATE

This is to certify that this professional training report is the bonafide work of **T.Mansura (41240038)** who has completed the training program in **"SATHYABAMA RESEARCH PARK"** under **"Exploring Bioanalytical Tools and Techniques DRUG DISCOVERY"** as a part of professional development under our supervision from 20.09.2023 to 25.09.2023.

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Exploring Bioanalytical Tools and Techniques for Drug Discovery

CERTIFICATE

This is to certify that T . Mansura 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.

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DECLARATION

I T. Mansura (41240038) hereby declare that the professional training report completed by me during my professional training at **Sathyabama Research Park** under the guidance of **Dr. A. Sabarivani , M.Tech., Ph. D.** and **Ms. Sindu Divakaran** is submitted in partial fulfilments of the requirements for the award of Degree in Bachelor of Technology in Biomedical Engineering.

T. Mansura
SIGNATURE OF THE CANDIDATE

DATE: 03.10.2023

PLACE : CHENNAI.

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ABSTRACT

The drug discovery is one of the major players guiding the development of the medicines, biotechnology & pharmacology field. Drug discovery is the process by which drugs are discovered and designed. It is a process which aims at identifying a compound therapeutically useful in curing & treating disease. The process of drug discovery involves the identification of candidates, synthesis, characterization, screening & assays for therapeutic efficacy. Once a compound has shown its value in these tests, it will begin the process of drug development prior to clinical trials. Developing a new drug is a tedious & expensive undertaking, despite promising discoveries and multibillion dollar investments for new drug development is quietly undergoing crisis. Currently, all existing therapies together hit only about 400 different drug targets. It is estimated that there are at least 10 times as many potential drug targets that could be exploited for future drug therapy.

CONTENTS

Chapter no.	Table of contents	Page no.
	Title	
	Bonafide	
	Declaration	
	Acknowledgement	
	Abstract	v
	Contents	vi
1	Introduction	1
2	Polymerase chain reaction	2
3	Reverse transition polymerase chain	4
4	Autoclave	5
5	Fermentation	7
6	Flah Chromatography	9
7	Drug Discovery	10
8	COPD	11
9	Biofilm	13
10	Chromatography	15
11	Natural Dye	18
12	Synthetic Dye	19
13	Actinobacteria as a source of biofertilizer	20
14	Conclusion	22
15	Reference	23

CHAPTER:1

INTRODUCTION

Drug discovery is the process of identifying and characterizing molecules with the potential to safely modulate disease, with a goal to bring medicines that can improve the lives of patients. It is a lengthy and resource intensive process, that requires close cooperation across multiple disciplines. Optimizing the process of drug discovery is of great interest to the pharmaceutical industry, as the efficient identification and selection of suitable drug candidates can have a dramatic impact on the cost and profitability of new medicines. This review will describe certain key facets of the drug discovery process, including drug discovery team composition, target selection, lead identification, and lead optimization. Factors influencing the balance of pharmaceutical, pharmacodynamic, and pharmacokinetic parameters will also be discussed.

CHAPTER:2

POLYMERASE CHAIN REACTION (PCR)

The polymerase chain reaction (PCR) is a method widely used to make millions to billions of copies of a specific DNA sample rapidly, allowing scientists to amplify a very small sample of DNA (or a part of it) sufficiently to enable detailed study. PCR was invented in 1983 by American biochemist Kary Mullis at Cetus Corporation; Mullis and biochemist Michael Smith, who had developed other essential ways of manipulating DNA the creation for which they were jointly awarded the Nobel Prize in Chemistry in 1993. PCR is fundamental to many of the procedures used in genetic testing and research, including analysis of ancient samples of DNA and identification of infectious agents. Using PCR, copies of very small amounts of DNA sequences are exponentially amplified in a series of cycles of temperature changes. PCR is now a common and often indispensable technique used in medical laboratory research for a broad variety of applications including biomedical research and criminal forensics.

The majority of PCR methods rely on thermal cycling. Thermal cycling exposes reactants to repeated cycles of heating and cooling to permit different temperature-dependent reactions—specifically, DNA melting and enzyme-driven DNA replication. PCR employs two main reagents—primers (which are short single strand DNA fragments known as oligonucleotides that are a complementary sequence to the target DNA region) and a DNA polymerase. In the first step of PCR, the two strands of the DNA double helix are physically separated at a high temperature in a process called nucleic acid denaturation. In the second step, the temperature is lowered and the primers bind to the complementary sequences of DNA. The two DNA strands then become templates for DNA polymerase to enzymatically assemble a new DNA strand from free nucleotides, the building blocks of DNA.

Almost all PCR applications employ a heat-stable DNA polymerase, such as Taq polymerase, an enzyme originally isolated from the thermophilic bacterium *Thermus aquaticus*. If the polymerase used was heat-susceptible, it would denature under the high temperatures of the denaturation step. Before the use of Taq polymerase, DNA polymerase had to be manually added every cycle, which was a tedious and costly process.

Applications of the technique : Include DNA cloning for sequencing, gene cloning and manipulation, gene mutagenesis; construction of DNA-based phylogenies, or functional analysis of genes; diagnosis and monitoring of genetic disorders; amplification of ancient DNA;[5] analysis of genetic fingerprints for DNA profiling (for example, in forensic science and parentage testing); and detection of pathogens in nucleic acid tests for the diagnosis of infectious diseases.



CHAPTER:3

REVERSE TRANSCRIPTION POLYMERASE CHAIN (RT-PCR)

Reverse Transcription Polymerase Chain Reaction (RT-PCR) is a laboratory technique combining reverse transcription of RNA into DNA and amplification of specific DNA targets using polymerase chain reaction (PCR). It is primarily used to measure the amount of a specific RNA. This is achieved by monitoring the amplification reaction using fluorescence, a technique called real-time PCR or quantitative PCR . Combined RT-PCR and qPCR are routinely used for analysis of gene expression and quantification of viral RNA in research and clinical settings. The close association between RT-PCR and qPCR has led to metonymic use of the term qPCR to mean RT-PCR. Such use may be confusing, as RT-PCR can be used without qPCR, for example to enable molecular cloning, sequencing or simple detection of RNA. Conversely, qPCR may be used without RT-PCR, for example to quantify the copy number of a specific piece of DNA.

RT –PCR PRINCIPLES :

RT-PCR, the RNA template is first converted into a complementary DNA (cDNA) using a reverse transcriptase (RT). The cDNA is then used as a template for exponential amplification using PCR. The use of RT-PCR for the detection of RNA transcript has revolutionized the study of gene expression in the following important ways: Made it theoretically possible to detect the transcripts of practically any gene.

- Enabled sample amplification and eliminated the need for abundant starting material required when using northern blot analysis.

CHAPTER:4

AUTOCLAVE

Autoclave is a machine used to carry out industrial and scientific processes requiring elevated temperature and pressure in relation to ambient pressure and/or temperature. Autoclaves are used before surgical procedures to perform sterilization and in the chemical industry to cure coatings and vulcanize rubber and for hydrothermal synthesis. Industrial autoclaves are used in industrial applications, especially in the manufacturing of composites.

Many autoclaves are used to sterilize equipment and supplies by subjecting them to pressurized saturated steam at 121 °C (250 °F) for around 30-60 minutes at a pressure of 15 ps above atmospheric pressure (205 kPa or 2.02 atm) depending on the size of the load and the contents. The autoclave was invented by Charles Chamberland in 1879, although a precursor known as the steam digester was created by Denis Papin in 1679. The name comes from Greek auto-, ultimately meaning self, and Latin clavis meaning key, thus a self-locking device.



Video demonstrating how autoclaves work Uses : Sterilization autoclaves are widely used in microbiology and mycology, medicine and prosthetics fabrication, tattooing and body piercing, and funerary practice. They vary in size and function depending on the media to be sterilized and are sometimes called retort in the chemical and food industries.

Typical loads include laboratory glassware, other equipment and waste, surgical instruments, and medical waste.

A notable recent and increasingly popular application of autoclaves is the pre-disposal treatment and sterilization of waste material, such as pathogenic hospital waste. Machines in this category largely operate under the same principles as conventional autoclaves in that they are able to neutralize potentially infectious agents by using pressurized steam and superheated water. A new generation of waste converters is capable of achieving the same effect without a pressure vessel to sterilize culture media, rubber material, gowns, dressings, gloves, etc. It is particularly useful for materials which cannot withstand the higher temperature of a hot air oven.

Autoclaves are also widely used to cure composites, especially for melding multiple layers without any voids that would decrease material strength, and in the vulcanization of rubber. The high heat and pressure that autoclaves generate help to ensure that the best possible physical properties are repeatable. Manufacturers of spars for sailboats have autoclaves well over 50 feet (15 m) long and 10 feet (3 m) wide, and some autoclaves in the aerospace industry are large enough to hold whole airplane fuselages made of layered composites.

Other types of autoclaves are used to grow crystals under high temperatures and pressures. Synthetic quartz crystals used in the electronics industry are grown in autoclaves. Packing of parachutes for specialist applications may be performed under vacuum in an autoclave, which allows the chutes to be warmed and inserted into their packs at the smallest volume.

CHAPTER:5

FERMENTATION

Fermentation is a metabolic process that produces chemical changes in organic substances through the action of enzymes. In biochemistry, it is narrowly defined as the extraction of energy from carbohydrates in the absence of oxygen. In food production, it may more broadly refer to any process in which the activity of microorganisms brings about a desirable change to a foodstuff or beverage. The science of fermentation is known as zymology. In microorganisms, fermentation is the primary means of producing adenosine triphosphate (ATP) by the degradation of organic nutrients anaerobically.

Humans have used fermentation to produce foodstuffs and beverages since the Neolithic age. For example, fermentation is used for preservation in a process that produces lactic acid found in such sour foods as pickled cucumbers, kombucha, kimchi, and yogurt, as well as for producing alcoholic beverages such as wine and beer. Fermentation also occurs within the gastrointestinal tracts of all animals, including humans. Industrial fermentation is a broader term used for the process of applying microbes for the large-scale production of chemicals, biofuels, enzymes, proteins and pharmaceuticals.

ROLES OF FERMENTATION :

Along with aerobic respiration, fermentation is a method to extract energy from molecules. This method is the only one common to all bacteria and eukaryotes. It is therefore considered the oldest metabolic pathway, suitable for primeval environments – before plant life on Earth, that is, before oxygen in the atmosphere.³⁸⁹ Nick Lane criticizes this proposal as the amount of energy released by fermentation is small, which can't lead to a thermodynamic driving force of prebiotic chemistry. The enzymes involved in fermentations, which are encoded by genes, could not have existed during prebiotic chemistry.

Yeast, a form of fungus, occurs in almost any environment capable of supporting microbes, from the skins of fruits to the guts of insects and mammals to the deep ocean. Yeasts convert (break down) sugar-rich molecules to produce ethanol and carbon dioxide.

Basic mechanisms for fermentation remain present in all cells of higher organisms. Mammalian muscle carries out fermentation during periods of intense exercise where oxygen supply becomes limited, resulting in the creation of lactic acid.⁶³ In invertebrates, fermentation also produces succinate and alanine.

Fermentative bacteria play an essential role in the production of methane in habitats ranging from the rumens of cattle to sewage digesters and freshwater sediments. They produce hydrogen, carbon dioxide, formate and acetate and carboxylic acids. Then consortia of microbes convert the carbon dioxide and acetate to methane.

CHAPTER:6

FLASH CHROMATOGRAPHY

Flash chromatography is sometimes called Flash column chromatography. This term was first coined by W. Clark Still and co-workers at Columbia University to describe the separation process using a gas-pressurized solvent reservoir.

Principle of Flash column chromatography In this chromatographic method, compressed gas is used to put pressure on the solvent (mobile phase) reservoir to accelerate the flow rate of the mobile phase so that superior chemical separation is achieved in less time than traditional gravity-based column chromatography. The principle of flash chromatography is basically similar to that of column chromatography. The chemicals in the mixture are separated based on their affinity for the mobile phase and stationary phase, which causes them to migrate through the column at various rates and come out from the bottom at different times.

CHAPTER:7

DRUG DISCOVERY

In the fields of medicine, biotechnology and pharmacology, drug discovery is the process by which new candidate medications are discovered.

Historically, drugs were discovered by identifying the active ingredient from traditional remedies or by serendipitous discovery, as with penicillin. More recently, chemical libraries of synthetic small molecules, natural products or extracts were screened in intact cells or whole organisms to identify substances that had a desirable therapeutic effect in a process known as classical pharmacology. After sequencing of the human genome allowed rapid cloning and synthesis of large quantities of purified proteins, it has become common practice to use high throughput screening of large compounds libraries against isolated biological targets which are hypothesized to be disease-modifying in a process known as reverse pharmacology. Hits from these screens are then tested in cells and then in animals for efficacy.

Application : When a drug is developed with evidence throughout its history of research to show it is safe and effective for the intended use in the United States, the company can file an application – the New Drug Application (NDA) – to have the drug commercialized and available for clinical application. NDA status enables the FDA to examine all submitted data on the drug to reach a decision on whether to approve or not approve the drug candidate based on its safety, specificity of effect, and efficacy of doses.

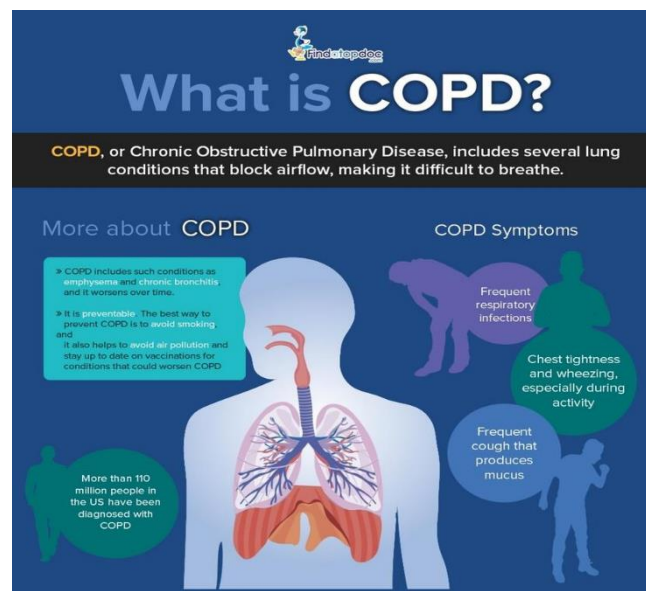
CHAPTER:8

CHRONIC OBSTRUCTIVE PULMANARY DISEASE (COPD)

Chronic obstructive pulmonary disease (COPD) is a type of progressive lung disease characterized by long-term respiratory symptoms and airflow limitation. The main symptoms of COPD include shortness of breath and a cough, which may or may not produce mucus. COPD progressively worsens, with everyday activities such as walking or dressing becoming difficult. While COPD is incurable, it is preventable and treatable. The two most common types of COPD are emphysema and chronic bronchitis and have been the two classic COPD phenotypes. Emphysema is defined as enlarged airspaces (alveoli) whose walls have broken down resulting in permanent damage to the lung tissue. Chronic bronchitis is defined as a productive cough that is present for at least three months each year for two years. Both of these conditions can exist without airflow limitation when they are not classed as COPD. Emphysema is just one of the structural abnormalities that can limit airflow and can exist without airflow limitation in a significant number of people. Chronic bronchitis does not always result in airflow limitation but in young adults who smoke the risk of developing COPD is high. Many definitions of COPD in the past included emphysema and chronic bronchitis, but these have never been included in GOLD report definitions. Emphysema and chronic bronchitis remain the predominant phenotypes of COPD but there is often overlap between them and a number of other phenotypes have also been described. COPD and asthma may coexist and converge in some individuals. COPD is associated with low-grade systemic inflammation.

The most common cause of COPD is tobacco smoking. Other risk factors include indoor and outdoor air pollution including dust, exposure to occupational irritants such as dust from grains, cadmium dust or fumes, and genetics, such as alpha-1 antitrypsin deficiency. In developing countries, common sources of indoor air pollution are the use of coal and biomass such as wood and dry dung as fuel for cooking and heating. The diagnosis is based on poor airflow as measured by spirometry.

Most cases of COPD can be prevented by reducing exposure to risk factors such as smoking and indoor and outdoor pollutants. While treatment can slow worsening, there is no conclusive evidence that any medications can change the long-term decline in lung function. COPD treatments include smoking cessation, vaccinations, pulmonary rehabilitation, inhaled bronchodilators and corticosteroids. Some people may benefit from long-term oxygen therapy, lung volume reduction and lung transplantation. In those who have periods of acute worsening, increased use of medications, antibiotics, corticosteroids and hospitalization may be needed.



CHAPTER:9

BIOFILM

A biofilm comprises any syntrophic consortium of microorganisms in which cells stick to each other and often also to a surface. These adherent cells become embedded within a slimy extracellular matrix that is composed of extracellular polymeric substances (EPSs). The cells within the biofilm produce the EPS components, which are typically a polymeric conglomeration of extracellular polysaccharides, proteins, lipids and DNA. Because they have three-dimensional structure and represent a community lifestyle for microorganisms, they have been metaphorically described as "cities for microbes".

Biofilms may form on living (biotic) or non-living (abiotic) surfaces and can be prevalent in natural, industrial, and hospital settings. They may constitute a microbiome or be a portion of it. The microbial cells growing in a biofilm are physiologically distinct from planktonic cells of the same organism, which, by contrast, are single cells that may float or swim in a liquid medium. Biofilms can form on the teeth of most animals as dental plaque, where they may cause tooth decay and gum disease.

Microbes form a biofilm in response to a number of different factors, which may include cellular recognition of specific or non-specific attachment sites on a surface, nutritional cues, or in some cases, by exposure of planktonic cells to sub-inhibitory concentrations of antibiotics. A cell that switches to the biofilm mode of growth undergoes a phenotypic shift in behavior in which large suites of genes are differentially regulated.

A biofilm may also be considered a hydrogel, which is a complex polymer that contains many times its dry weight in water. Biofilms are not just bacterial slime layers but biological systems; the bacteria organize themselves into a coordinated functional community.

Properties :

Biofilms are usually found on solid substrates submerged in or exposed to an aqueous solution, although they can form as floating mats on liquid surfaces and also on the surface of leaves, particularly in high humidity climates. Given sufficient resources for growth, a biofilm will quickly grow to be macroscopic (visible to the naked eye). Biofilms can contain many different types of microorganism, e.g. bacteria, archaea, protozoa, fungi and algae; each group performs specialized metabolic functions. However, some organisms will form single-species films under certain conditions. The social structure (cooperation/competition) within a biofilm depends highly on the different species present.



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CHAPTER:10

CHROMATOGRAPHY

In chemical analysis, chromatography is a laboratory technique for the separation of a mixture into its components. The mixture is dissolved in a fluid solvent (gas or liquid) called the mobile phase, which carries it through a system (a column, a capillary tube, a plate, or a sheet) on which a material called the stationary phase is fixed. Because the different constituents of the mixture tend to have different affinities for the stationary phase and are retained for different lengths of time depending on their interactions with its surface sites, the constituents travel at different apparent velocities in the mobile fluid, causing them to separate. The separation is based on the differential partitioning between the mobile and the stationary phases. Subtle differences in a compound's partition coefficient result in differential retention on the stationary phase and thus affect the separation. Chromatography may be preparative or analytical. The purpose of preparative chromatography is to separate the components of a mixture for later use, and is thus a form of purification. This process is associated with higher costs due to its mode of production. Analytical chromatography is done normally with smaller amounts of material and is for establishing the presence or measuring the relative proportions of analytes in a mixture. The two types are not mutually exclusive.

Chromatography terms :

- Analyte – the substance to be separated during chromatography. It is also normally what is needed from the mixture.
- Analytical chromatography – the use of chromatography to determine the existence and possibly also the concentration of analyte(s) in a sample.
- Bonded phase – a stationary phase that is covalently bonded to the support particles or to the inside wall of the column tubing.

- Chromatogram – the visual output of the chromatograph. In the case of an optimal separation, different peaks or patterns on the chromatogram correspond to different components of the separated mixture.
- Chromatograph – an instrument that enables a sophisticated separation, e.g. gas chromatographic or liquid chromatographic separation.
- Chromatography – a physical method of separation that distributes components to separate between two phases, one stationary (stationary phase), the other (the mobile phase) moving in a definite direction.
- Eluent (sometimes spelled eluant) – the solvent or solvent mixture used in elution chromatography and is synonymous with mobile phase.
- Eluate – the mixture of solute (see Eluite) and solvent (see Eluent) exiting the column.
- Effluent – the stream flowing out of a chromatographic column. In practice, it is used synonymously with eluate, but the term more precisely refers to the stream independent of separation taking place.
- Eluite – a more precise term for solute or analyte. It is a sample component leaving the chromatographic column.
- Eluotropic series – a list of solvents ranked according to their eluting power.
- Immobilized phase – a stationary phase that is immobilized on the support particles, or on the inner wall of the column tubing.
- mobile phase – the phase that moves in a definite direction. It may be a liquid (LC and capillary electrochromatography (CEC)), a gas (GC), or a supercritical fluid (supercritical-fluid chromatography, SFC). The mobile phase consists of the sample being separated/analyzed and the solvent that moves the sample through the column.

- Retention time – the characteristic time it takes for a particular analyte to pass through the system (from the column inlet to the detector) under set conditions. See also: Kovats' retention index
- Sample – the matter analyzed in chromatography. It may consist of a single component or it may be a mixture of components. When the sample is treated in the course of an analysis, the phase or the phases containing the analytes of interest is/are referred to as the sample whereas everything out of interest separated from the sample before or in the course of the analysis is referred to as waste.
- Solute – the sample components in partition chromatography.
- Solvent – any substance capable of solubilizing another substance, and especially the liquid mobile phase in liquid chromatography.
- Stationary phase – the substance fixed in place for the chromatography procedure. Examples include the silica layer in thin-layer chromatography
- Detector – the instrument used for qualitative and quantitative detection of analytes after separation.
- Chromatography is based on the concept of partition coefficient. Any solute partitions between two immiscible solvents. When we make one solvent immobile (by adsorption on a solid support matrix) and another mobile it results in most common applications of chromatography. If the matrix support, or stationary phase, is polar (e.g. paper, silica etc.) it is forward phase chromatography, and if it is non-polar (C-18) it is reverse phase.

CHAPTER:11

NATURAL DYE

Natural dyes are dyes or colorants derived from plants, invertebrates, or minerals. The majority of natural dyes are vegetable dyes from plant sources—roots, berries, bark, leaves, and wood—and other biological sources such as fungi.

Archaeologists have found evidence of textile dyeing dating back to the Neolithic period. In China, dyeing with plants, barks and insects has been traced back more than 5,000 years. The essential process of dyeing changed little over time. Typically, the dye material is put in a pot of water and heated to extract the dye compounds into solution with the water. Then the textiles to be dyed are added to the pot, and held at heat until the desired color is achieved. Textile fibre may be dyed before spinning or weaving ("dyed in the wool"), after spinning ("yarn-dyed") or after weaving ("piece-dyed"). Many natural dyes require the use of substances called mordants to bind the dye to the textile fibres. Mordants (from Latin *mordere* 'to bite') are metal salts that can form a stable molecular coordination complex with both natural dyes and natural fibres. Historically, the most common mordants were alum (potassium aluminum sulfate—a metal salt of aluminum) and iron (ferrous sulfate). Many other metal salt mordants were also used, but are seldom used now due to modern research evidence of their extreme toxicity either to human health, ecological health, or both. These include salts of metals such as chrome, copper, tin, lead, and others. In addition, a number of non-metal salt substances can be used to assist with the molecular bonding of natural dyes to natural fibres—either on their own, or in combination with metal salt mordants—including tannin from oak galls and a range of other plants/plant parts, "pseudo-tannins", such as plant-derived oxalic acid, and ammonia from stale urine. Plants that bio-accumulate aluminum have also been used.

CHAPTER:12

SYNTHETIC DYE

A colorant is any substance that changes the spectral transmittance or reflectance of a material. Synthetic colorants are those created in a laboratory or industrial setting. The production and improvement of colorants was a driver of the early synthetic chemical industry, in fact many of today's largest chemical producers started as dye-works in the late 19th or early 20th centuries, including Bayer AG(1863). Synthetics are extremely attractive for industrial and aesthetic purposes as they have they often achieve higher intensity and color fastness than comparable natural pigments and dyes used since ancient times. Market viable large scale production of dyes occurred nearly simultaneously in the early major producing countries Britain (1857), France (1858), Germany (1858), and Switzerland (1859), and expansion of associated chemical industries followed. The mid-nineteenth century through WWII saw an incredible expansion of the variety and scale of manufacture of synthetic colorants. Synthetic colorants quickly became ubiquitous in everyday life, from clothing to food. This stems from the invention of industrial research and development laboratories in the 1870s, and the new awareness of empirical chemical formulas as targets for synthesis by academic chemists. The dye industry became one of the first instances where directed scientific research lead to new products, and the first where this occurred regularly.

CHAPTER:13

Actinobacteria as a source of biofertilizer

Actinobacteria are one of the largest bacterial phyla with high G + C content in their genome. They are ubiquitous and distributed in both terrestrial and aquatic environments. They are also spore-forming and mostly filamentous. However, some may grow anaerobically; most of the genera are aerobic. Actinobacteria produce branching filaments and mycelial development in certain species (De-Simeis and Serra 2021). Actinobacteria are diverse and widely distributed in a soil environment that makes up about 10% to 50% of the total soil microbial population (Barka et al. 2015). Actinobacteria have been identified as significant producers of secondary metabolites, utilized as antimicrobial, anticancer, antioxidant, antiviral, larvicidal, insecticidal, and biocontrol properties (Singh and Dube 2018). Because they possess various beneficial characteristics, actinobacteria are believed to be unique among rhizosphere microorganisms in terms of plant growth promotion and disease management (Sathya et al. 2017). Due to their filaments and sporulation capacities, they can adhere to rhizospheric soil particles and develop a tight relationship with plants. Actinobacteria can produce a substantial quantity of phytohormone that promotes plant growth development. They also contributed to solubilize phosphate, zinc, and potassium in micronutrient-deficient soils and play a significant role in plant growth promotion (Mitra et al. 2022).

The diversity of living creatures found at the species, inter-species, and intra-species levels is called biodiversity in ecology. Microbes are useful and can be utilized to earn a lot of money for agriculture and human health in the long run (Kumar et al. 2021, Suyal et al. 2021). Microbial diversity outnumbers eukaryotic species in rhizospheric soil ecosystems. Rhizosphere soil contains more than 10 billion microorganisms and makes up thousands of various species. This vast diversity is making attention to microbial biodiversity classified into archaea, eubacteria, and fungi (Praeg et al. 2019).

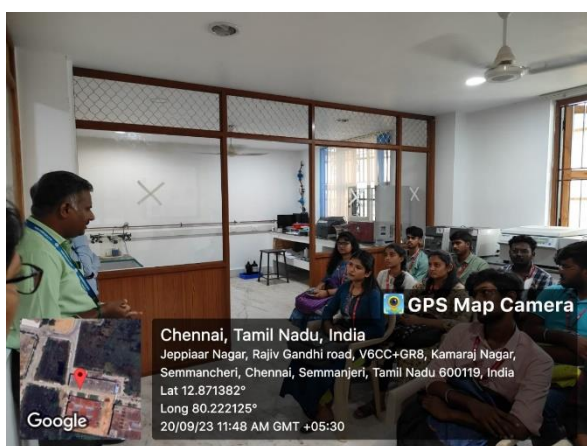
The actinobacteria phylum is classified into 6 different classes, 29 orders, 67 families, 391 genera, and 3900 species. The six classes are Acidimicrobiia, Coriobacteriia, Rubrobacteria, Thermoleophilia, Actinobacteria, and Nitriliruptoria. Among them, 90% of the microbes are dominated by the class of Actinobacteria. Next, 4.6% genera come under Coriobacteriia, and the Rubrobacteria class classifies 0.5% genera. *Streptomyces* is the most common and dominant genera under actinobacteria, including 961 species under this genus (Barka et al. [2015](#)).



CHAPTER-14

CONCLUSION

Modern drug discovery involves the identification of screening hits, medicinal chemistry and optimization of those hits to increase the affinity, selectivity (to reduce the potential of side effects), efficacy/potency, metabolic stability (to increase the half-life), and oral bioavailability



CHAPTER-15

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