



ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS



STUDY MATERIAL FOR B.Sc. MICROBIOLOGY

BIO ENTREPRENEURSHIP AND BIOBUSINESS

SEMESTER – VI



ACADEMIC YEAR 2025-26

PREPARED BY

MICROBIOLOGY DEPARTMENT



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INDEX

UNIT	CONTENT	PAGE NO
I	BIO – ENTREPRENEURSHIP	03-23
II	ENTREPRENEURSHIP OPPORTUNITY IN AGRICULTURAL BIOTECHNOLOGY	24-50
III	ENTREPRENEURSHIP OPPORTUNITY IN INDUSTRIAL BIOTECHNOLOGY	51-87
IV	STEM CELLS PRODUCTION	88-103
V	PROJECT MANAGEMENT	104-128



Unit - I

Bio-Entrepreneurship

Bio-Entrepreneurship refers to the process of launching and managing businesses based on biotechnology and life sciences innovations. It involves applying scientific research into commercial applications.

Fields Involved:

- Pharmaceuticals
- Agricultural Biotechnology
- Environmental Biotechnology
- Bioinformatics
- Medical Devices
- Industrial Biotech

Bridge between science and business: It connects academic research with the commercial world, taking discoveries from the lab to the public.

Profit-driven innovation: It focuses on creating, developing, and marketing biotechnology-based products to generate profit.

A multidisciplinary field: It combines scientific knowledge, business skills, leadership, and a willingness to take calculated risks.

Key activities and goals

Commercializing innovations: Turning biological and life science discoveries into marketable products and services.

Addressing global challenges: Developing solutions for issues like new medical treatments, increasing crop yields, and creating biofuels.

Building businesses: Creating ventures, often start ups that are built on cutting-edge technologies like gene editing, drug discovery, and personalized medicine.

Characteristics of a Bio-Entrepreneur:

- Strong scientific background
- Risk-taking ability
- Problem-solving mindset
- Business acumen



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



- Good communication skills

Steps in Bio-Entrepreneurship:

1. Idea Generation – Based on research, unmet needs.
2. Feasibility Analysis – Market study, technology assessment.
3. Business Plan Development– Vision, goals, finance, structure.
4. Intellectual Property Protection – Patents, trademarks.
5. Funding – Government grants, venture capital, incubators.
6. Product Development & Trials

Examples of bio entrepreneurship

Medical biotechnology: Developing new therapies, drugs (like insulin), diagnostic tests, and gene therapies.

Agricultural biotechnology: Creating crops that are resistant to pests or herbicides to increase yields.

Industrial biotechnology: Developing sustainable products like biofuels and renewable chemicals.

Introduction to Bio business

Bio business, also known as the biotechnology industry, is a commercial field that applies biological processes and systems to create products and services for profit in areas like healthcare, agriculture, and the environment. It involves translating scientific discoveries into commercial ventures, requiring a blend of life science knowledge with business skills like management, marketing, and finance. Bio business is a dynamic industry with a significant impact on addressing global challenges and a rapidly growing market.

Scope of Bio-Business:

- Healthcare & Pharmaceuticals – vaccines, drugs, diagnostics
- Agricultural Biotechnology – GM crops, bio-pesticides, bio-fertilizers
- Environmental Biotechnology – waste treatment, bio-remediation
- Industrial Biotechnology – biofuels, enzymes, bioplastics
- Food & Nutrition– probiotics, nutraceuticals
- Bioinformatics – data analytics for genomics, drug discovery

Components of Bio-Business:

- Product Development– from lab to market



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



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- Technology Transfer– from academia to industry
 - Intellectual Property Rights (IPR) – patents, licensing
 - Business Development – market analysis, partnerships
 - Funding – from public or private sectors
 - Marketing & Sales – distribution, branding

Bio-Business Models:

- B2B– Biotech firm supplies to pharmaceutical companies
- B2C – Direct sale of biotech-based consumer products
- Licensing Model – Licensing of patented technology
- Spin-offs – University innovations turned into start-ups

Government Support (India):

- BIRAC – funding and incubation
- DBT, DST – research grants
- Start up India, Make in India – support schemes
- Challenges in Bio-Business:
 - Regulatory delays
 - High Research & Development cost
 - Market competition
 - Public perception and ethics
 - Technology obsolescence

Opportunities:

- Growing demand in healthcare
- Agri-tech innovation
- Environmental sustainability
- Export potential
- Personalized medicine



ACADEMIC YEAR 2025-2026, SEMESTER – VI STUDY MATERIAL FOR B.Sc. MICROBIOLOGY BIO ENTREPRENEURSHIP AND BIOBUSINESS



Why bio business is important?

Addresses global challenges: It provides innovative solutions for major issues such as disease prevention, food security, and environmental protection.

Drives innovation: It is a major driver of innovation, transforming scientific research into tangible products and services that benefit society.

Economic impact: It is a significant and rapidly growing part of the global economy, creating jobs and spurring economic growth.

Core elements for success

Innovation and research: The foundation of bio business is a pipeline of new ideas and scientific discoveries.

Entrepreneurship: The ability to identify opportunities, manage risk, and build a commercial venture is crucial.

Funding: Securing investment is a critical step for developing and scaling new technologies.

Skilled workforce: Bio businesses need professionals with a mix of scientific, business, and management skills.

SWOT analysis of Bio business

A SWOT analysis is a study conducted by a company to identify its strengths, weaknesses, opportunities, and threats.

It involves identifying strengths like innovative technology and a skilled team; weaknesses such as limited funding or regulatory hurdles; opportunities like new market trends and partnerships; and threats such as competitor activity or changing regulations. This strategic tool helps a company assess internal and external factors to develop a roadmap for success.





**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Strengths (Internal)

1. Innovation-Driven Sector

- Biotechnology is based on cutting-edge research, offering new solutions for healthcare, agriculture, and environmental challenges.

2. Wide Applications

- Bio businesses serve multiple industries: pharmaceuticals, agriculture (GM crops, biofertilizers), food processing, waste management, etc.

3. Skilled Human Resources

- India and many countries have strong academic and research institutions producing biotech professionals.

4. Government Initiatives & Support

- Support through schemes like DBT-BIRAC in India, and tax incentives in many countries for biotech R&D.

5. Global Demand

- Growing interest in sustainable, eco-friendly products creates a strong international market.

Weaknesses (Internal)

1. High Research & Development Costs

- Product development requires long-term investment with no immediate returns.

2. Time-Consuming Approval Process

- Regulatory processes (clinical trials, safety tests) can delay product launch significantly.

3. Lack of Infrastructure

- In some regions, there's inadequate lab equipment, cold chain logistics, and pilot-scale production facilities.

4. Global Competition

- Competing with well-funded multinational companies is tough for small bio businesses.

5. Uncertain Policy Environment

- Regulatory policies can change based on political shifts or public protests (e.g., GMO bans).

6. Biosecurity Risks

- Misuse of biotech products (like in bioterrorism) can lead to strict regulations, affecting genuine research.



7. Limited Access to Capital

- Early-stage biotech start ups may struggle to attract investors due to long gestation periods.

8. Public Misconceptions

- Lack of awareness about biotechnology can lead to resistance (e.g., GMOs).

Opportunities (External)

1. Personalized Medicine & Diagnostics

- Growing demand for genetic testing, personalized drug development, and vaccine innovations.

2. Agricultural Advancements

- Development of drought-resistant, pest-tolerant crops; increased acceptance of biofertilizers and biopesticides.

3. Sustainable Solutions

- Bioremediation, biodegradable plastics, and biofuels are gaining attention due to climate concerns.

4. International Collaboration

- Partnering with global biotech firms can provide access to technology and markets.

5. Start up Ecosystem Growth

- Incubators, accelerators, and government-backed innovation hubs are increasing support for bio-entrepreneurs.

Threats (External)

1. Ethical & Legal Challenges

- Concerns over cloning, gene editing, and use of embryonic cells can affect public trust and legal support.

2. Intellectual Property Disputes

- Patent infringement issues can arise, especially when working on similar biological products or processes.

Competitor activity: Aggressive actions by competitors.

Regulatory changes: New or changing government regulations that impact the business.

Market saturation: Difficulty standing out in a crowded marketplace.

Economic downturns: Negative economic conditions that affect sales or funding.



Supply chain disruptions: Issues with the availability or cost of raw materials.

Steps of SWOT Analysis

1. Identify the Objective

- Clearly define the purpose of the SWOT analysis (e.g., launch of a new bio product, evaluating a start up, entering a new market).

2. Internal Analysis

Focuses on factors within the organization

a) Strength (S)

b) Weaknesses (W)

3. External Analysis

Focuses on factors outside the organization

c. Opportunities (O)

d. Threats (T)

4. Record and Organize Findings

- Create a *4-box SWOT matrix* with Strengths, Weaknesses, Opportunities, and Threats clearly listed.

5. Analyze and Prioritize

- Identify which strengths can be used to grab opportunities.

- Determine which weaknesses could expose the business to threats.

- Focus on areas with high impact.

6. Create Actionable Strategies

Use SWOT results to form strategies:

- SO (Strength-Opportunity): Maximize strengths to seize opportunities

- WO (Weakness-Opportunity): Improve weaknesses to exploit opportunities

- ST (Strength-Threat): Use strengths to counter threats

- WT (Weakness-Threat): Minimize weaknesses to avoid threats

Uses of SWOT Analysis in Bio Business

1. Strategic Planning



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



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2. Decision Making
 3. Resource Allocation
 4. Risk Management
 5. Product Development
 6. Competitive Advantage
 7. Partnership Evaluation
 8. Market Entry

Ownership

Sole Proprietorship

A sole proprietorship is owned by only one person. This is the most common form of business ownership. It can include small retail stores, mechanic services and even inventors or musicians seeking to sell their products online. It is fairly easy to establish a sole proprietorship, and the process of running them is fairly.

Advantages

- i. Ease of starting and ending the business
- ii. Being your own boss.
- iii. Pride of ownership as sole proprietors have taken the risk and deserve the credit.
- iv. Leaving a legacy behind for future generations.

Partnership

A partnership is similar to sole proprietorship, except more than one person is involved. Two or more people come together to work at a given business and share in the profits (or losses) or that business. Like sole proprietorship, a partnership is relatively easy to set up and doesn't have to pay the sort of taxes that larger corporations do. However, the partners themselves are responsible for business losses and liabilities, and partnerships founded on informal agreements may run into interpersonal problems when the company struggles.

Advantages of Partnerships

- i. More financial resources. Two or more people pool their money and credit.
- ii. Shared management and pooled/complementary knowledge. Partners provide different skills and perspectives.
- iii. Longer survival. Partners are four times as likely to succeed as sole proprietorships.



Franchising

Franchising is a business arrangement in which the owner of a trademark, trade name, or copyright has licensed others to use it in selling goods or services. It can be sole proprietorship, partnership or company form.

Advantages

i. Personal ownership

You are still your own boss, although you must follow the rules, regulations, and procedures of the franchise.

ii. An Established Business

A franchise offers the advantage of operating under the banner of an already established business. The ideas, the brand, the operating techniques and much more are already tried and tested and in place ready to be implemented again and again at a new location as each franchisee takes up the mantle.

Private limited company/LTD

A private limited company - also referred to as LTD - is an incorporated business entity that is privately held and controlled. The ownership of the business is divided by shares in the company. Those who own the shares are known as shareholders.

This type of business ownership provides limited liability to the owners. Limited liability provides the shareholders' personal assets with protection from liabilities incurred by the business.

Advantages

Private limited companies provide limited liability to their shareholders.

Shares cannot be sold to the public (the current owners decide to whom they will sell them). Therefore the company is protected from loss of ownership and control.

Public Limited Company

- Shares are publicly traded on stock exchanges.
- Owned by many shareholders.
- Can raise large capital.
- Suitable for large-scale biotech firms.

Advantages

- Capital can be easily generated through trading shares publicly.
- Owners have limited liability.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Cooperative Ownership

- Owned and operated by a group (e.g., farmers, researchers).
- Democratic structure.

Profits shared equally among members.

- Focus on community benefit.

Advantages

They are relatively easy to start.

Management style is democratic, with each member having voting rights.

Government/Institutional Ownership

- Funded and owned by the government or research institutions.
- Examples: ICMR labs, CSIR institutes.
- Focuses on public health, agriculture, or national biotech goals.

Intellectual Property (IP) Ownership in Bio Business

- Crucial in biotech for protecting innovations.
- **Types:**
 - Patents: Protect inventions (e.g., drugs, genetically modified organisms).
 - Trademarks: Protect brand names/logos.
 - Copyrights: Protect research papers, software.
 - Trade Secrets: Protect processes/formulas not disclosed publicly.

Entrepreneurship Development

Entrepreneurship Development is defined as a process of enhancing the skill set and knowledge of entrepreneurs regarding the development, management and organization of a business venture while keeping in mind the risks associated with it. This is carried out through training programs and sessions which are aimed at accentuating entrepreneurial acumen. Pursuing this field as a career, you will be working towards facilitating skill development amongst budding entrepreneurs and assisting them to tackle their struggles with building their businesses.

Types of Entrepreneurship Development

The types of entrepreneurship development programs depend on the types of entrepreneurs. As per research, different types of entrepreneurships have been identified. All types of entrepreneurships are catalysts for economic development.



1. Innovative Entrepreneur

Such an entrepreneur is one who aggressively gathers information, generates new business ideas based on the information and puts these ideas into practice. They have a shrewd business sense and create new products and new markets. Steve Jobs and Mark Zuckerberg are examples.

2. Adoptive Entrepreneur

Such an entrepreneur is skilled in enhancing already existing ideas and technology to create a competitive advantage. They can exogenously enhance or change technologies and create more jobs. For example, development of smaller shopping malls and manufacturing of car parts etc.

3. Fabian Entrepreneur:

Such an entrepreneur has a more orthodox and traditional approach to business. They do not believe in taking risks or innovating. Usually, they are the second-generation business owners of an existing business.

4. Drone Entrepreneur

Such entrepreneurs are laggards in their fields. They are not motivated by new and exciting opportunities to grow their business. Instead, they are happy to struggle to make ends meet. Their approach to business can push them out of competition, especially when the market becomes too competitive.

Entrepreneurs can also be classified on the basis of some other markers:

Based on the type of business

Agricultural Entrepreneur: An individual involved in the business of agriculture and any of the related activities such as cultivation, irrigation, agricultural technology, etc.

Manufacturing Entrepreneur: An entrepreneur, who identifies market gaps, researches the resources and raw materials to fulfil the gap, finds the technology and produces the finished product.

Trading Entrepreneur: All manufacturers do not engage in marketing their products themselves. They look for trading partners who can increase the reach of their products to businesses and consumers. These trading entrepreneurs are the links between the manufacturer, the wholesaler, the retailer and the consumer.

Based on technology use:

1. Technical Entrepreneurs: These entrepreneurs are intrigued by new technology and start businesses in the field of science and technology. They offer products and services related to technology.

2. Non-technical Entrepreneurs: These entrepreneurs do not concern themselves with the technological aspects of products and services they produce. They develop marketing and promotional strategies for their products and services.



Other Types of Entrepreneurs:

1. Women Entrepreneurs:

While entrepreneurship has been on the rise, development of women entrepreneurship has gathered steam only in recent years. This is especially true in India. With more women having access to education and technology, they can explore their creative sides to actually create profitable businesses. As per the Indian government, an enterprise that gives 51% stake to women, including 51% of the employment generated to women, is considered a women entrepreneurship enterprise. The Government of India is giving a fillip to the development of women entrepreneurship by providing vocational and skill-building courses at minimal or no cost and by providing loans and help for women to set up their own businesses.

2. First-generation Entrepreneurs

These are individuals who do not belong to business families and have started their businesses without any family support or backing. Deregulation has helped many individuals set up their own businesses. Innovative entrepreneurs are often first-generation entrepreneurs.

Since all the above categories display distinct characteristics, the types of entrepreneurship development programs for each of these categories must be focused and different.

Entrepreneurial process

The entrepreneurial process involves identifying a market opportunity, developing a viable business concept, planning and launching the business, and managing its growth.

Overview of the Entrepreneurial Process

The entrepreneurial process can be divided into five key stages:

- Ideation
- Feasibility Analysis
- Business Planning
- Execution
- Growth

Each stage is crucial and requires distinct considerations and actions to increase the chances of success.





**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Ideation

Ideation or idea generation is when entrepreneurs generate and refine business ideas. It involves identifying a problem or opportunity in the market and developing innovative solutions. Creativity, market awareness, and customer needs are crucial during this stage.

Entrepreneurs can brainstorm ideas individually or in teams, conduct market research to identify gaps and trends and seek feedback from potential customers and industry experts. The goal is to build a wide range of ideas and evaluate their feasibility and potential for success.

Tips for Ideation

Conduct market research to validate the demand and viability of your ideas.

Improve your concept by seeking feedback from potential customers and industry experts.

Feasibility Analysis

Feasibility analysis is the stage where entrepreneurs assess their business idea's viability and potential success. It involves evaluating market potential, competition, resources, and risks. Market research is essential to understand the target market's size, demographics, and purchasing behaviours. Competitive analysis helps identify existing players, their strengths, weaknesses, and opportunities for differentiation. Assessing available financial and operational resources helps determine the idea's feasibility.

Entrepreneurs must also evaluate potential risks and challenges, such as regulatory requirements, technological constraints, and market uncertainties. This analysis helps them make informed decisions about whether to pursue the idea, modify it, or abandon it.

Tips for Feasibility Analysis:

Identify your target market and understand its size, demographics, and needs.

Analyze your competition to identify unique selling points and differentiation strategies.

Business Planning

Business planning is the stage where entrepreneurs create a detailed roadmap for their venture. It involves developing a business model, crafting a marketing strategy, establishing financial projections, and setting operational goals.

The business model outlines how the venture will create, deliver, and capture value. It defines the target customer segments, value proposition, revenue streams, and cost structure. The marketing strategy outlines how the product or service will be positioned, promoted, and distributed to reach the target market effectively.

Financial projections estimate revenue, expenses, and profitability over a specific period. They help entrepreneurs understand the business's financial viability and funding requirements. Setting



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



operational goals and defining key performance indicators (KPIs) provides a clear focus for implementation and evaluation.

Tips for Business Planning

Define your business model and your value proposition.

Develop a marketing strategy highlighting your target audience, channels, and messaging.

Execution

Execution is the stage where entrepreneurs transform their plans into action. It involves building a team, developing products or services, and launching the business. This stage requires effective project management, resource allocation, and adaptability to navigate challenges and capitalize on opportunities.

Building a talented team is crucial. Entrepreneurs need to identify the necessary skills, recruit the right people, and create a culture that aligns with the vision and values of the business. Developing and refining the product or service based on market feedback is essential to meet customer needs and differentiate from competitors.

Launching the business involves bringing the product or service to market, establishing operations, and implementing marketing and sales strategies. It requires effective coordination of activities, monitoring progress, and making adjustments as needed.

Tips for Execution

Build a talented team with complementary skills and shared values.

Prioritize customer feedback and iterate your products or services accordingly.

Growth

The final stage of the entrepreneurial process is growth. This stage involves scaling the business, expanding into new markets, and optimizing operations. It involves strategic decision-making, resource allocation, and continuous innovation to sustain and increase market share. Entrepreneurs must seize growth opportunities while maintaining the core values and vision that led to their initial success.

Entrepreneurs must develop growth strategies that align with their long-term vision. This may include entering new markets, expanding product lines, forming strategic partnerships, or pursuing mergers and acquisitions. Marketing, sales, and customer acquisition strategies are crucial in attracting and retaining customers.

Optimizing operations involves streamlining processes, leveraging technology, and improving efficiency. By constantly adjusting to changing market dynamics, entrepreneurs can stay ahead of their competitors and take advantage of new opportunities.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Tips for Growth

Develop a growth strategy that aligns with your long-term vision.

Invest in marketing, sales, and customer acquisition strategies to expand your reach.

Addressing Challenges and Obstacles

1. Limited Funding
2. Competition
3. Uncertainty

Conclusion

Embarking on the entrepreneurial journey can be both rewarding and challenging. By understanding and navigating the entrepreneurial process, entrepreneurs can increase their chances of success. From ideation to growth, each stage requires careful planning, execution, and adaptability. Remember to remain persistent, seek feedback, and embrace innovation as you transform your vision into a thriving business.

Government schemes and Funding

1. Start up India Seed Fund Scheme

As a part of the programme, the Start up India Seed Fund Scheme was introduced in 2021 to facilitate the process of creating a robust start up ecosystem and providing financial assistance to start ups for proof of concept, prototype development, product trials, market-entry, and commercialization.

Eligibility:

Should be recognised by DPIIT.

Start ups should not have received more than Rs 10 lakh of monetary support under other significant government schemes.

The Start up shall have been in existence for no more than two years at the time of application.

Should be using Technology as its core product or service, creating innovative solutions in different sectors.

Must have a business idea to develop the product with a scope of scaling

Benefits:

Under this scheme, Financial assistance up to Rs 50 lakh will be provided to start ups at an early stage through incubators.

The incubator will disburse the seed fund to an eligible start up:



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



- As a grant for validation of “prototype development, proof of concept or product trials”- Up to Rs. 20 Lakh

- Investment for commercialisation, market-entry, or scaling up through debt-linked instruments - Up to Rs. 50 Lakh

Once incubated, physical infrastructure, testing support, mentoring for prototype or commercialization, human resources, and legal compliances are provided to the start ups, all by the incubators.

For eligible start ups, there are income tax and capital gains tax exemptions.

Post funding process:

Each incubator must track specific criteria for each beneficiary start up. Every beneficiary start up must present the reports to its incubators periodically. The data is submitted to Start up India in real-time via their web dashboards and further to the EAC quarterly. Each Start up’s return on investment is also reported by the designated incubator.

2. Women Entrepreneurship Platform (WEP)

The Women Entrepreneurship Platform (WEP) is a NITI Aayog program that connects women from all over India through a single online platform to help them achieve their dream of starting and growing their own businesses. It is built on three foundation pillars:

Iccha Shakti - Power of Aspiration

- Refers to the desire or will to start a business. Karma Shakti - Power of Action

- This is the implementation phase, where women start or expand their business.

Gyaan shakti - Power of Knowledge

- Represents the learning phase, where women seek skills, information, and training.

Eligibility:

Any woman entrepreneur with an established or new start up or just a business idea can benefit from this scheme.

Benefits:

WEP actively hosts a wide range of events as a platform, providing resources and promoting entrepreneurial communities.

It provides monetary assistance, including seed capital, growth capital, line of credit (LOC), and non-credit support.

Promotion of offline initiatives and outreach programs by partnering with other organizations.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Incubation and acceleration support to start ups founded or co-founded by women entrepreneurs registered with the program.

Identification of skill gaps and providing online/ offline training on these aspects.

Marketing and networking support to early-stage or established entities

Compliance services to registered users, which provides them with the essential tools to adhere to legal compliances, perform registrations, furnish accounts, make loan applications, provide license counselling, and so on.

To provide better support, WEP has tied up with some fortune companies like CRISIL, Facebook, SIDBI, NASSCOM, DICE, FICCI, Mann Foundations, Shop clues, CII, and many others. The fortunes will play a key role in developing different skill sets important for a robust entrepreneurial ecosystem.

3. SAMRIDH Scheme

SAMRIDH or Start up Accelerators of Meity for Product Innovation, Development, and Growth, launched by the Ministry of Electronics and IT, aims to provide funding and acceleration to start ups, predominantly software start ups. The investment is extensively for brilliant solutions and proof of concepts through selected accelerators. The selected accelerators are responsible for providing a customized acceleration programme for selected 300 start ups.

Eligibility:

For Start ups:

Must be recognised by DPIIT.

Must be in the Early-growth stage.

The product of the start up must be software-based.

For Accelerators:

Must have operations in India.

Must have been in the business of incubation for more than three years and supported more than 50 start ups.

Must have the required infrastructure and targeted acceleration programmes.

Benefits:

This scheme provides a platform for product development and business scaling in terms of investment.

To provide customer connect, investor connects, and international connect services.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Financial support of up to Rs 40 lakh to the start ups according to their current valuation and growth stage through accelerators.

Customized acceleration programs for start ups and provided product and capacity enhancement services.

4. NSIC- IT Incubator

For the holistic development of the field of Information and Communications Technology (ICT), the National Small Industries Corporation- IT Incubator (NSIC IT Incubator) scheme encourages the spirit of entrepreneurship by turning innovative ideas into viable commercial ventures.

Eligibility:

Must be a first-generation entrepreneur.

Must be an MSME.

Must be willing to pay the monthly license fee and other payable charges.

Benefits:

The scheme provides built-in space (infrastructure), access to business centres, software libraries, and internet facilities.

Initial level counselling and skill training.

Mentoring and legal services along with market exposure.

Access to Seed/Venture capital and various funding sources based on the viability of the business plan and the process.

Documentation support and various statutory formalities are required for starting an enterprise.

5. Pradhan Mantri Mudra Yojana (PMMY)

The PMMY scheme launched in 2015 aims to provide MUDRA Loans to small and micro enterprises through various commercial banks, RRBs, SFBs, NBFCs, and Cooperative Banks. The loan range may vary depending on growth, development, and funding needs. The MUDRA loan can be categorized into

Sishu- Upto Rs. 50,000

Kishore- Rs. 50,000 to 5 Lakh

Tarun- Rs. 5 Lakh to 10 Lakh

Eligibility:

Must have their business plans for service sector activities or trading or manufacturing activities.

In the case of an individual applicant, the age range must be between 18 and 65 years.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Must be a non-corporate and non-farm small and micro-enterprise.

Benefits:

MUDRA loans can be taken for small amounts at affordable interest rates; also, the credit guarantee is borne by the Government.

The Mudra loan scheme in collaboration with the “Make In India” campaign, helps in fostering innovation, facilitating investment, and improving skill development.

Women Borrowers can avail this scheme with discounted interest rates.

Relief of up to 1500 Crores will be provided to the Borrowers as Interest Subsidy under the Mudra Shishu Category.

Small scale Industries

Small Scale Industries (SSI) are industries that manufacture, produce and render services on a small or micro scale level. These industries make a one-time investment in machinery, plant, and equipment, but it does not exceed Rs.10 crores and annual turnover does not exceed Rs.50 crore.

The SSI's are the lifeline of the economy, especially in developing countries like India. These industries are generally labour-intensive, and hence they play an important role in the creation of employment.

Characteristics of SSI

Ownership

SSI's generally are under single ownership. So it can either be a sole proprietorship or sometimes a partnership firm.

Management

Generally, both the management and the control is with the owner/owners. Hence the owner is actively involved in the day-to-day activities of the business.

Labor Intensive

SSI's dependence on technology is pretty limited. Hence they tend to use labour and manpower for their production activities.

Flexibility

SSI's are more adaptable to their changing business environment. So in case of amendments or unexpected developments, they are flexible enough to adapt and carry on, unlike large industries.

Limited Reach

Small scale industries have a restricted zone of operations. Hence, they can meet their local and regional demand.



Resources Utilisation

They use local and readily available resources which helps the economy fully utilise natural resources with minimum wastage.

Examples and Ideas of SSIs in India

Bakeries	Detergent powder making
Spinning and weaving industry	Spices making
School stationeries	Chocolate making
Coconut oil making	Xerox and printing
Photography	Pickle manufacturing industry
Agarbatti making	Incense stick manufacturing industry
Beauty parlours	Paper plate manufacturing industry
Rice mill	Candle manufacturing

Types of SSI

Manufacturing Industries - power looms, engineering units,

Ancillary Industries - Automobiles

Service Industries - Schools, Hospital

Export Units

Cottage Units - jaggery, pickles, papad,

Village Industries - pottery, weaving, and bamboo crafts

Need for small-scale industries

Employment Generation: SSIs are labour-intensive and create a large number of job opportunities, especially in rural and semi-urban areas, which helps lower unemployment rates.

Rural and Regional Development: They are vital for developing less-developed regions by establishing businesses that create local jobs and infrastructure, helping to reduce economic imbalances between different areas.

Entrepreneurship and Self-Employment: SSIs provide a platform for individuals to become entrepreneurs with relatively low initial investment, fostering self-employment and a culture of innovation.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Resource Utilization: They make optimum use of locally available resources, including raw materials and skilled/unskilled labor, which minimizes production costs and reduces dependence on external sources.

Income and Wealth Distribution: By decentralizing economic activity, SSIs contribute to a more equitable distribution of income and wealth across the country.

Rationale for small-scale industries

Low Capital Requirement: Compared to large-scale industries, SSIs are less capital-intensive, making them a suitable choice for developing economies where capital may be scarce.

Support for Large Industries: SSIs act as a crucial "seedbed" or ancillary to large industries by supplying components and raw materials, increasing overall industrial efficiency.

Innovation and Specialization: They often cater to niche markets and can introduce new ideas, technologies, and specialized products, contributing to a more diversified economy.

Export and GDP Contribution: SSIs contribute significantly to a nation's GDP and exports, helping to earn foreign exchange and improve the balance of trade.

Cost-Effectiveness: By using local resources and sometimes simpler technology, they can produce goods at lower costs, which can be passed on to consumers as more affordable products.

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UNIT - II

Entrepreneurship Opportunity in Agricultural Biotechnology:

Business opportunity

i) Seed Technology Innovations

Developing improved seed varieties is a core aspect of agricultural biotechnology. This includes genetic modification, increasing disease resistance, and boosting crop yields. There's a huge potential for companies focused on developing seeds for specific climates, needs, or crops. Imagine producing seeds with enhanced nutrient content or increased tolerance to drought and temperature fluctuations. These can make a significant difference in today's agricultural challenges.

Biofertilizers and Biopesticides

Sustainable agriculture is increasingly important. Biofertilizers and biopesticides are environmentally friendly alternatives to synthetic ones, offering a considerable market opportunity. Developing and distributing effective biofertilizers and biopesticides could be a rewarding enterprise. Farmers seek solutions that enhance soil health while reducing reliance on synthetic inputs.

Crop Protection and Pest Management

Pest management and disease control are critical to agriculture. Companies focused on developing bio-control methods or novel crop protection strategies are in demand. Farmers face increasing pressure to minimize pesticide use, creating a huge opportunity to help with these struggles.

Biofuel Production and Innovation

Biofuel production offers a potential avenue for sustainable energy solutions. Companies focusing on new and innovative biofuels that can be economically viable for wide-scale adoption are encouraged.

Livestock Biotechnology Solutions

Livestock biotechnology is another promising sector, with opportunities focusing on animal health, improving productivity, and ensuring sustainability. Consider creating innovative solutions for disease prevention or developing ways to enhance animal feed, boosting efficiency. There are opportunities to analyze livestock data for better herd management and improved production outcomes.

ii) Essential requirement

Entrepreneurship in agricultural biotechnology requires a blend of scientific knowledge and business skills, including a deep understanding of biotech applications and market needs, strong



ACADEMIC YEAR 2025-2026, SEMESTER – VI STUDY MATERIAL FOR B.Sc. MICROBIOLOGY BIO ENTREPRENEURSHIP AND BIOBUSINESS



business acumen, and the ability to manage finances, regulations, and partnerships. Essential requirements include a strong educational background in biology or a related field, practical laboratory and bioinformatics skills, risk-taking ability, and expertise in areas like intellectual property and sustainable practices.

Scientific and technical requirements

Educational background: A bachelor's or advanced degree in agricultural biotechnology, genetics, plant science, or a related field is crucial.

Technical skills: Proficiency in laboratory techniques, bioinformatics software, and a strong grasp of concepts like genetic engineering, recombinant DNA technologies, and gene function is necessary.

Research ability: Strong research skills are needed to identify opportunities and develop new products and processes.

Business and entrepreneurial skills

Market and business acumen: The ability to identify market opportunities, develop a comprehensive business plan, conduct market research, and understand profit margins is essential.

Financial literacy: Expertise in financial management, budgeting, pricing strategies, and forecasting is critical for securing investment and managing the business's finances.

Risk-taking: A willingness to take risks is a fundamental trait for any entrepreneur.

Management skills: The ability to manage various aspects of the business, including human relations, supplier and customer relations, production, and marketing.

Strategic planning: Skills in building strategic partnerships, protecting intellectual property, and balancing innovation with ethical considerations are vital for long-term success.

Operational and regulatory requirements

Regulatory compliance: Familiarity with the complex regulatory landscape governing agricultural biotechnology is a must.

Project management: The ability to manage long timelines, as products often have a lengthy time to market, is crucial.

Stakeholder management: The capacity to collaborate with a diverse range of stakeholders, including scientists, investors, regulators, and customers, is a key requirement.

iii) Marketing strategies

Marketing: Focuses on Customer's needs.

- Customer enjoys supreme importance.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



- Converting customer's needs into product.
- Profits through customer satisfaction.
- Emphasis is given on product planning and development to match products with the market.
- Integrated approach to marketing is practiced.
- The principle of caveat vendor (let the seller beware) is followed.

The marketing mix, often called the 4 Ps, is a framework of controllable, tactical marketing elements that a company uses to promote its product or service. The four components are Product (what the company sells), Price (the cost to the customer), Place (where the product is available), and Promotion (how the company communicates with customers).



1. Product

The first element of marketing mix is product. A Product is anything that can be offered to a market for attention, acquisition, use, or consumption that might satisfy a want or need. Products include physical objects, services, events, persons, places, ideas or mixes of these. This element involves decisions concerning product line, quality, design, brand name, label, after sales services, warranties, product range, etc.

2. Price

The second element is the price, which affects the volume of sales. It is one of the most difficult tasks of the marketing manager to fix the right price. The variables that significantly influence the price of a product are: demand of the product, cost, competition and government regulation. The product mix includes: determination of unit price of the product, pricing policies and strategies, discounts and level of margins, credit policy, terms of delivery, payment, etc. Pricing decisions have direct influence on the sales volume and profits of the firm. Price, therefore, is an important element of the marketing mix. Right price can be determined through pricing research and by adopting test-marketing techniques.

3. Promotion

Promotion refers to the various activities undertaken by the enterprise to communicate and promote its products to the target market. The different methods of promoting a product are through advertisement, personal selling, sales promotion and publicity.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



4. Place or Physical Distribution:

This is another key marketing mix tool, which stands for the various activities the company undertakes to make the product available to target customers. Place mix or delivery mix is the physical distribution of products at the right time and at the right place. It refers to finding out the best means of selling, sources of selling (wholesaler, retailers, and agents), inventory control, storage facility, location, warehousing, transportation, etc. This includes decisions about the channels of distribution, which make the product available to target customers at the right time, at the right place and at the right price.

iv) Schemes

Entrepreneurship in agricultural biotechnology is supported by various schemes, including the

Rashtriya Krishi Vikas Yojana (RKVY-RAFTAAR)

Rashtriya Krishi Vikas Yojana (RKVY) is a centrally sponsored scheme that was launched in 2007 by the Government of India. The scheme aims to provide financial support to states and union territories for the development of agriculture and allied sectors.

AgriTech government initiatives, financing incubation centers and offering grants of up to Rs. 25 lakh for cutting-edge AgriTech start ups.

Funding: Initially launched with 100% central assistance, it now operates on a 60:40 (Centre:State) funding pattern, with a 90:10 pattern for North-Eastern and Himalayan states. For Union Territories, the funding is 100% central grant.

Objectives

To strengthen the farmers' efforts by creating required pre and postharvest agri-infrastructure, which will increase access to quality inputs, storage, market facilities, etc., and enable farmers to make informed choices.

Plan & Execution of Schemes as per local/ farmers needs by providing Autonomy flexibility to States.

Promotion of value chain addition linked production models helps farmers to increase their income as well as encourage production and productivity.

Generation of Additional Income by mitigating the risk of farmers with a focus on additional income generation activities – like integrated farming, mushroom cultivation, beekeeping, aromatic plant cultivation, floriculture, etc.

Attending national priorities through several sub-schemes.

Youth Empowerment: To empower youth through skill development, innovation, and agri entrepreneurship-based agribusiness models that attract them to agriculture.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



2. Pradhan Mantri Formalisation of Micro Food Processing Enterprises (PMFME)

The Pradhan Mantri Formalisation of Micro Food Processing Enterprises (PMFME) scheme is a Centrally Sponsored Scheme launched by the Ministry of Food Processing Industries to support the growth of the unorganized food processing sector in India.

Promote formalization: Transition micro-enterprises from the unorganized to the organized sector.

Provide credit-linked capital subsidy of 35% (up to Rs. 10 lakh) for individual units.

Funding: The expenditure is shared between the Central and State governments.

Focus: The scheme gives special focus to women entrepreneurs, Aspirational districts, and minor forest produce in Tribal Districts.

3. NABARD's Agri Infrastructure Fund (AIF)

The National Agriculture Infra Financing Facility, also known as the Agriculture Infrastructure Fund (AIF), was launched by the Prime Minister of India on May 15, 2020. NABARD's Agri Infrastructure Fund (AIF) is a government-backed, 10-year financial scheme providing medium to long-term debt financing to create post-harvest management infrastructure and community farming assets. It aims to improve the agricultural sector by supporting projects like warehouses, cold chains, and community farming assets with a budget of ₹1 lakh crore, through a special refinancing facility from NABARD to various lending institutions.

Beneficiaries: Includes farmers, Farmer Producer Organizations (FPOs), marketing cooperatives, agri-entrepreneurs, and other eligible entities.

Lending Institutions: Multiple institutions can provide loans under the scheme, including commercial banks, cooperative banks, and NCDC.

4. Pradhan Mantri Kisan Sampada Yojana (PMKSY)

Objectives

Pradhan Mantri Kisan Sampada Yojana is a scheme by the Indian government to bring about modernization and strengthen the Indian agricultural and food processing industry. The most important goals of the PMKSY are:

To develop the modern infrastructure related to the processing and preserving of agricultural products. This involves the making of cold chains, warehouses and food processing units.

To improve value addition to the agricultural products through commercialization, food processing, agri-business and the allied activities.

To create job opportunities, especially in rural areas, through investing and entrepreneurship in the food processing industry.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



To boost the farmers' income, minimize post-harvest losses, expand market access and achieve better prices for the farm products.

To improve food safety, quality requirements and food preservation hygienic practices in food production.

To attract supply chain management to interlink farmers with the national and international markets to minimize wastage and increase market access.

An amount of ₹6,520 crore has been allocated for the period 2021–2026. The funding is provided as a grant-in-aid for component schemes that boost the food processing sector, helping to increase processing levels, enhance exports, and reduce post-harvest waste.

5. Pradhan Mantri Fasal Bima Yojana (PMFBY)

The Pradhan Mantri Fasal Bima Yojana (PMFBY) is India's flagship crop insurance scheme, launched in 2016, to provide financial protection to farmers against crop loss from natural calamities, pests, and diseases. It aims to support agricultural production with affordable insurance premiums and a comprehensive risk cover from the pre-sowing to post-harvest stages, following the principle of "One Nation, One Crop, One Premium".

The scheme covers all food crops (cereals, millets, and pulses), oilseeds, and annual commercial/horticultural crops.

It offers affordable premiums, with the maximum for farmers capped at 2% for Kharif food and oilseed crops and 5% for commercial and horticultural crops.

Implementation: The scheme is implemented through a network of insurance companies and banks, with the final selection of the insurer for each state done by the State Government.

v) Challenges Facing Agri-Entrepreneurs

1. Access to Capital: One of the primary challenges facing agri-entrepreneurs is access to capital. Securing funding is often a significant barrier for agripreneurs, especially for those in developing countries or rural areas. High initial investment costs for land, equipment, and technology can deter potential entrepreneurs. Traditional financial institutions may perceive agriculture as risky, leading to limited access to loans or investment capital.

2. Market Access and Distribution: Another obstacle for agri-entrepreneurs is accessing markets and establishing efficient distribution channels. Small-scale farmers and niche agricultural producers may struggle to compete with larger, more established players in the industry. Additionally, navigating complex supply chains and reaching consumers directly can pose logistical challenges.

3. Climate Change and Environmental Sustainability: Climate change presents a formidable challenge for agri-entrepreneurs, impacting weather patterns, water availability, and crop yields. Erratic weather conditions, droughts, floods, and pests can disrupt agricultural production, leading



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



to crop failures and financial losses. Sustainable practices can require significant investment and expertise. Balancing economic viability with environmental stewardship is a delicate task for agri-entrepreneurs. Agriculture practices are becoming increasingly important, but implementing these practices can require significant investment and expertise. Balancing economic viability with environmental stewardship is a delicate task for agri-entrepreneurs.

4. Technological Adoption: While technological advancements hold immense potential to enhance productivity and efficiency in agriculture, adoption rates among agripreneurs vary widely. Limited access to information, inadequate training, and skepticism about new technologies can hinder adoption. Additionally, the high cost of technology and the lack of infrastructure in rural areas pose additional challenges.

5. Policy and Regulatory Hurdles: Agripreneurs often face regulatory complexities and bureaucratic hurdles that can stifle innovation and growth. Compliance with food safety regulations, environmental standards, and land use regulations can be time-consuming and costly. Inconsistent policies and lack of government support for entrepreneurship in agriculture further exacerbate these challenges.

Case study on Plant cell and Tissue culture

A case study on plant cell and tissue culture involves applying the technique to a specific goal, such as creating disease-free plants, producing valuable compounds, or improving a crop's traits.

Commercial Production of Banana via Tissue Culture

Background:

Banana is a key fruit crop in tropical countries. Traditional propagation using suckers is slow and disease-prone. Tissue culture provides a solution for rapid, large-scale, and disease-free banana plant production.

Objective:

To develop a reliable micropropagation method for mass production of high-yielding and disease-free banana plants (*Musa* spp.).

Technique Used:

1. Explant Selection

- Shoot tips or meristematic tissues from healthy mother plants.

2. Surface Sterilization:

- Treated with 70% ethanol and sodium hypochlorite to eliminate microbes.

3. Culture Medium:

- MS (Murashige and Skoog) medium with growth regulators:



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



-
- Cytokinin's (e.g., BAP) for shoot induction.
 - Auxins (e.g., NAA or IBA) for root formation.

4. Culture Conditions:

- Maintained under controlled temperature ($25\pm 2^{\circ}\text{C}$), light (16h photoperiod), and humidity.

5. Stages of Micropropagation:

- Initiation → Multiplication → Rooting → Hardening → Field transfer

Outcome:

- A single explant can produce 1000+ clones in a year.

Plants are genetically uniform, pest-free and have early maturity and high yield.

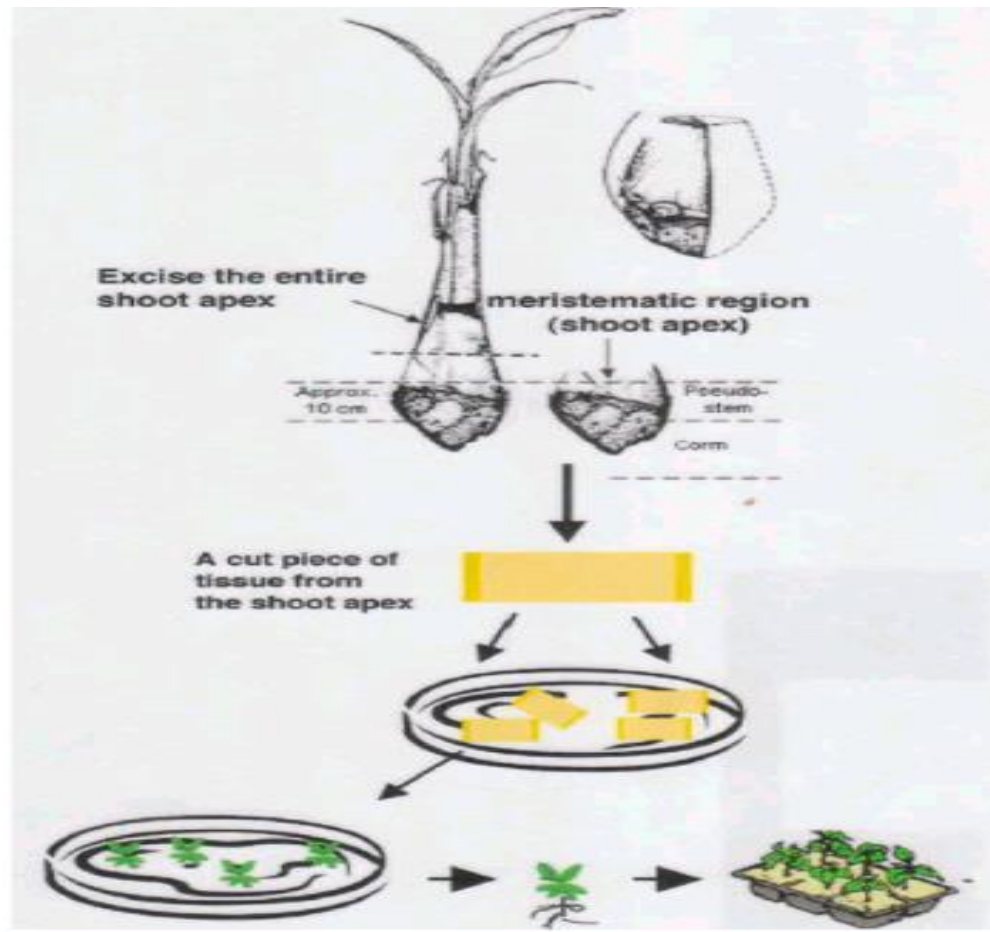
Applications:

- Used widely in banana plantations across India and abroad.
- Also applied to other crops: sugarcane, potato, orchid, etc.

Conclusion:

Plant tissue culture is a successful tool for mass propagation, germplasm conservation, and crop improvement in modern agriculture.

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Scope

Commercial and agricultural applications

Micropropagation: Rapidly produces a large number of genetically identical plants (clones) from a small amount of starting material, including ornamental plants, vegetables, and fruit plants.

Disease eradication: Creates virus-free and disease-free plants, which is especially important for vegetatively propagated crops like potatoes and strawberries.

Conservation: Preserves rare or endangered plant species and maintains germplasm.

Production of secondary metabolites: Grows cells in bioreactors to produce economically important compounds like pharmaceuticals.

Synthetic seeds: Produces "synthetic seeds" containing an embryo that can be germinated like a normal seed.

Genetic improvement and research

Genetic engineering: A key tool for introducing new genes into plants to improve traits like disease resistance or nutritional value.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Somatic hybridization: Fuses the protoplasts of different species to create novel hybrids, including those that would be difficult to cross through conventional breeding.

Production of dihaploids: Generates homozygous lines more quickly for use in breeding programs by culturing haploid cells from anthers or pollen.

In vitro selection: Allows for the screening of cells for desirable traits like salt tolerance or resistance to pests, rather than having to screen whole plants.

Fundamental research: Provides a controlled environment to study plant cell biology, genetics, and metabolism, including growth, differentiation, and gene function.

Polyhouse Culture

Polyhouse farming, or protected cultivation, is a farming method where crops are grown inside a climate-controlled structure covered with polyethylene sheets to protect them from weather and pests. This technique allows for year-round cultivation of high-value crops like vegetables, flowers, and fruits, leading to higher yields and more efficient use of resources like water and fertilizer. The "culture" associated with it is a modern, tech-integrated approach to agriculture that is more profitable and sustainable compared to traditional methods, especially in regions with variable climates.

Polyhouse Culture Involves

Structure: A framed structure, typically made of G.I. steel or MS angle, is covered with high-quality, UV-resistant polyethylene film.

Climate control: The structure allows for controlled conditions, managing aspects like temperature, humidity, and ventilation. Equipment like exhaust fans and evaporative cooling pads are used to maintain a favorable internal climate.

Crop protection: It provides a barrier against harsh weather like rain and wind, and protects crops from pests and diseases, which reduces crop loss.

Resource management: Systems like drip irrigation are commonly used for efficient watering, and Fertigation allows for precise nutrient delivery.

Crops grown: Common crops include high-value items such as tomatoes, capsicum, cucumbers, roses, gerberas, and strawberries, which are also suitable for export.

Scope

Year-Round & Off-Season Production: The primary advantage is the ability to grow crops irrespective of external weather conditions (e.g., extreme heat, heavy rain, frost, wind) ensuring a continuous supply to the market and allowing farmers to capitalize on premium off-season pricing.



ACADEMIC YEAR 2025-2026, SEMESTER – VI STUDY MATERIAL FOR B.Sc. MICROBIOLOGY BIO ENTREPRENEURSHIP AND BIOBUSINESS



Increased Yield and Quality: The controlled microclimate (temperature, humidity, light, Co₂ levels) promotes optimal plant growth, leading to significantly higher yields (2x to 5x or more compared to open fields) and superior quality produce (uniform size, color, longer shelf life).

Resource Efficiency: Polyhouse farming employs efficient water and nutrient management techniques, such as drip irrigation and fertigation, which can reduce water usage by up to 70% compared to traditional irrigation methods.

Pest and Disease Management: The enclosed structure acts as a physical barrier against many pests and diseases, allowing for more effective Integrated Pest Management (IPM) strategies and reducing the reliance on chemical pesticides.

Cultivation of High-Value Crops: It opens opportunities to grow high-value and exotic crops (e.g., colored capsicum, cherry tomatoes, gerbera flowers, strawberries) that may not be feasible in open fields in a specific region, catering to niche markets and export demands.

Rural Entrepreneurship and Employment: The establishment and management of polyhouses create employment opportunities in rural areas for skilled and unskilled labor, from construction to daily operations and post-harvest handling.

Adaptability to Challenging Environments: Polyhouse technology allows for cultivation in marginal or otherwise uncultivable lands, such as urban areas with limited space or regions with saline water issues, by integrating with technologies like hydroponics or vertical farming.

Government Support and Subsidies: Many governments, including in India, offer significant subsidies and technical support to encourage farmers to adopt polyhouse technology, making the initial investment more affordable for small and marginal farmers.

Herbal Bulk Drug Production

Withania somnifera (Ashwagandha)

Introduction:

Withania somnifera, commonly known as Ashwagandha, is a medicinal plant used widely in Ayurvedic medicine. The roots are the main source of withanolides, the active ingredients used in bulk drug production for stress relief, immunity boosting, and anti-inflammatory applications.

Objective:

To study the process of producing herbal bulk drugs from Ashwagandha and its commercialization.

Key Steps in Herbal Bulk Drug Production:

Raw Material

- Cultivation of Ashwagandha in dry regions (Rajasthan, Madhya Pradesh).



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Processing: Harvested plant parts (e.g., leaves, roots, flowers) are washed, cleaned of impurities, and dried to specific moisture levels to prevent spoilage.

Fragmentation: The dried plant material is often cut or ground into smaller pieces to increase the surface area for extraction.

Extraction: Solvents are used to dissolve and draw out the desired bioactive compounds from the plant material. Different extraction methods can be employed depending on the nature of the compound.

Filtration: The liquid extract is separated from the solid plant residue through filtration.

Concentration: The solvent is removed from the liquid extract, often through evaporation or distillation, to produce a concentrated crude extract.

Purification: Further steps are taken to refine the crude extract and remove undesirable components.

Standardization: This crucial step involves standardizing the extract to a specific concentration of key bioactive markers to ensure consistent quality and therapeutic activity across different batches.

Quality control: Strict checks are performed throughout the entire process to ensure the final product is safe, potent, and free from contaminants.

Formulation: The standardized bulk drug can be further processed into various final dosage forms like tablets, capsules, or powders.

Packaging: The final products are packaged for distribution, with manufacturers often providing end-to-end solutions that include sourcing, production, quality checks, and packaging.

Applications:

- Used in capsules, syrups, tablets, and tonics.
- Exported as a bulk extract to pharma and nutraceutical industries.

Scope

Worldwide there is a growing demand for Ayurveda and other traditional forms of medicine.

In India, about 80% of the rural population uses medicina or indigenous systems of medicine.

Recently there has been a shift in universal trend from synthe to herbal medicine, which we can say 'Return to Nature'

Medicinal plants have been known for millennia & highly esteemed all over the world as a rich source of medicinal agents.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



In our country, there are so many plants available, therefore India known as "Medicinal Garden of World'.

Herbs have been known since the era of civilization and are highly esteemed all over the world as a rich source of medicinal agents.

The popularity of natural products is increasing day by day due to the facts that they are comparatively safe, less toxic, less side effects, easily available and affordable prices when compared to synthetic drugs.

The herbal drug industry is a very fast growing sector in the international market. In India, various system of medicine like Siddha, Unani, Homeopathy, Yoga & Naturopathy are ing utilized for the Health care of people.

Turnover of the industry is more than Rs. 80 billion.

Herbal exports include medicines of AYUSH (Ayurveda, Unani, Siddha and homoeopathy) products, which occupy a share of Indian pharmaceutical export.

More than 70% of India's 1.1 billion populations still use the non-allopathic system of medicine.

Herbal Industry' has reveled that currently, the Indian herbal market size is estimated at 7000 crore & over 3600 crore of herbal raw materials & medicine are exported by India.

Name	City
Ansar Drug Laboratories	Surat (Gujrat)
Acis Laboratories	Kanpur (UP)
Allen Laboratories Pvt. Ltd	Kolkata (WB)
Basic Ayurveda	Ghaziabad (UP)
Dabur India Ltd	Ghaziabad (UP)
Herbals (APS) Pvt. Ltd	Patna

Nutraceuticals

Nutraceuticals are products derived from food sources that provide health benefits beyond basic nutrition, often used for disease prevention and treatment. The term combines "nutrient" and "pharmaceutical" and includes a wide range of items such as dietary supplements (vitamins, minerals, herbs) fortified foods, and specific food-based preparations. They are intended to have a positive impact on health, ranging from improving well-being to treating or preventing chronic diseases.

Types of nutraceuticals

Dietary supplements: Products like vitamins, minerals, herbs, and amino acids, available in forms such as pills, capsules, or powders.



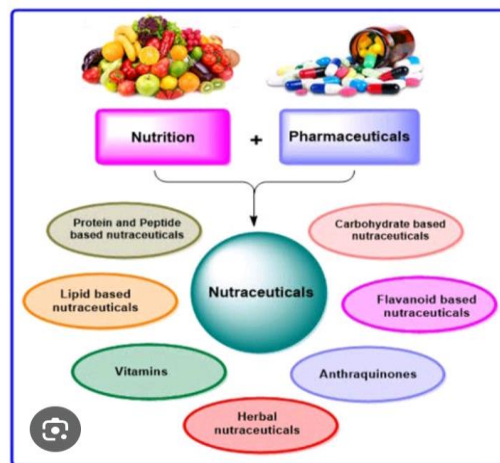
ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS



Functional foods: Foods that have been fortified with extra nutrients or bioactive compounds to enhance their health benefits, such as milk with vitamin D or orange juice with calcium.

Probiotics: Live microorganisms that, when consumed in adequate amounts, provide health benefits, particularly for gut health.

Herbal products: Preparations made from plants, such as extracts from turmeric (curcumin) or other herbs.



Case Study: Curcumin in the Treatment of Neurodegenerative Disorders and Depression

Background:

Curcumin is the principal bioactive compound in *Curcuma longa* (turmeric), widely studied for its anti-inflammatory, antioxidant, and neuroprotective properties. Recent research highlights its potential in managing neurodegenerative diseases (like Alzheimer's, Parkinson's) and depression.

Objective of Study:

To evaluate the efficacy and mechanism of curcumin in improving symptoms of neurodegenerative diseases and depressive disorders using both clinical and preclinical models.

Key Findings:

1. Neuroprotective Action:

- Curcumin reduces oxidative stress in neurons by scavenging free radicals.
- Inhibits amyloid plaque formation in Alzheimer's disease by binding to amyloid- β proteins.
- Prevents neuronal cell death (apoptosis) by modulating mitochondrial pathways.

2. Anti-inflammatory Effects:

- Downregulates pro-inflammatory cytokines (e.g., TNF- α , IL-6).
- Inhibits NF- κ B signaling, a key pathway in neuroinflammation.



3. Antidepressant Potential:

- Enhances serotonin, dopamine, and norepinephrine levels in the brain.
- Modulates the HPA axis, which is often overactive in depression.
- Comparable effects to standard antidepressants in mild to moderate depression (shown in several clinical trials).

Clinical Studies:

- Double-blind, placebo-controlled trial (Lopresti et al., 2014):
- Curcumin (500 mg twice daily) significantly improved mood in patients with major depressive disorder after 8 weeks.
- Animal models: Show improvements in memory, learning, and reduced anxiety in rats induced with Alzheimer-like conditions.

Applications:

- Can be used as a dietary supplement or in adjunct therapy for patients with neurodegenerative and mood disorders.
- Potential for development into plant-based pharmaceuticals.

Scope

- 1. Advanced Delivery Systems:** Future nutraceuticals may incorporate innovative delivery systems like nanotechnology, liposomes, and microencapsulation to enhance bioavailability and efficacy.
- 2. Synthetic Nutrients:** Advances in biotechnology may lead to the development of synthetic nutrients that are more efficient and sustainable to produce than traditional sources.
- 3. Functional Foods:** Nutraceuticals may be incorporated into everyday foods and beverages, making it easier for people to consume health-enhancing ingredients without the need for supplements.
- 4. Anti-Aging and Longevity:** Research into the aging process and the role of nutraceuticals in extending lifespan and improving the quality of life in older adults will likely expand.
- 5. Regulation and Safety:** As the industry grows, there will be increasing scrutiny on the safety and efficacy of nutraceuticals. Regulation may become more stringent to protect consumers.
- 6. Global Market Expansion:** The nutraceutical market is likely to continue its global expansion, with increased adoption in emerging markets as consumer awareness and disposable income rise.
- 7. Combination Products:** Nutraceuticals that combine multiple health benefits in one product (e.g., a supplement that supports heart health, joint health, and cognitive function) could become more prevalent.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



8. Digital Health Integration: Nutraceuticals may be integrated into digital health platforms and apps, allowing for real-time monitoring and adjustment of dietary plans based on an individual's health data.

9. Nutrigenomics: Advancements in nutrigenomics, the study of how individual genetics influence responses to nutrition, may lead to highly personalized nutraceutical recommendations.

Value-added herbal products

Value-added herbal products are processed forms of raw herbs that improve quality, shelf life, and efficacy for greater commercial value. Examples include powders, extracts, oils, and formulations like herbal shampoos, cosmetics, and nutraceuticals, created through processes such as drying, extraction, and blending. Value addition ensures higher quality standards, meets consumer needs with diversified products, and enhances market competitiveness.

Case Study: Value-Added Herbal Products by Himalaya Wellness Company

Title:

“Transforming Traditional Herbs into Global Wellness Products: The Success of Himalaya Herbal”

Background:

Himalaya Wellness Company (formerly Himalaya Drug Company) is one of India's leading herbal product companies. Founded in 1930, it pioneered the use of Ayurvedic herbs in modern dosage forms like tablets, syrups, creams, and cosmetics. The brand operates in over 90 countries, using value addition techniques to convert raw herbs into effective, standardized wellness products.

Key Herbs Used:

- Ashwagandha – for stress relief
- Neem – for skin care
- Turmeric (*Curcuma longa*) – anti-inflammatory
- Tulsi (Holy Basil) – immunity booster
- Aloe Vera – skincare and digestion

Value Addition Process:

1. Sourcing: Herbs are procured from GAP-certified farms, often under contract farming models.

2. Processing: Herbs undergo:

- Drying and powdering
- Extraction of active ingredients
- Filtration and concentration



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



3. Formulation: The extracts are used to prepare:

- Capsules, tablets, syrups
- Face washes, creams, shampoos
- Herbal teas and wellness supplements

4. Quality Control: Standardization ensures consistent dosage and safety.

5. Packaging & Branding: Attractive, modern packaging with global appeal.

6. Distribution: Products sold through pharmacies, supermarkets, online platforms, and exported internationally.

Scope

- Increased Farmer Income: Value addition brings 3–5× returns compared to raw herb sales.
- Women Employment: Packaging and manufacturing units employ thousands of women.
- Consumer Trust: Branded herbal products increase consumer confidence and accessibility.
- Global Recognition: Ayurveda promoted globally as science-backed wellness.

Conclusion:

This case study demonstrates how value addition in herbal products can transform rural livelihoods, promote traditional knowledge, and create global business opportunities. By investing in R&D, quality control, and branding, companies can bridge the gap between traditional medicine and modern consumer needs.

Bio-Ethanol

Ethanol (Ethyl alcohol) a colorless, in-flammable liquid. It is spirituous in odor. It is also known as grain alcohol, spirit and gasohol it is a good solvent for fats, resins, dyes, etc. It can be used as a fuel for lamps and stoves. In recent years, it is also used to run spark-ignited gasoline style internal combustion engines. Ethanol prepared from bioresources is called bioethanol

In biotechnology-based industries, ethanol is produced from wastes by the fermentative action of microbes. Any waste rich in carbohydrate can be used as the substrate to produce the environment by the activity of man are used ethanol. Renewable wastes being released in to manufacture ethanol. So there is no need to use living natural resources to make ethanol, As wastes are taken as raw materials, ethanol production opens a way to reuse wastes to clean up the environment.

Ethanol is prepared from cellulose-rich plant materials such as sugarcane, corn, switchgrass over 90% of global ethanol production. Bioethanol and others. This cellulosic ethanol accounts for can be prepared from Cane juice, Sugar beets, Sugar beet molasses, Cassava, Poplar, Yams, Crop wastes.



ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS



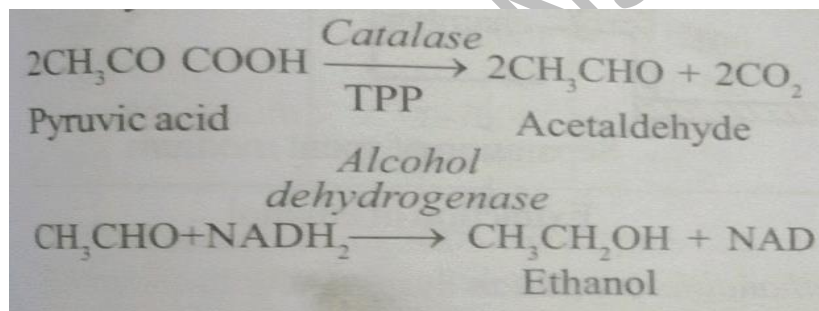
In the first generation in ethanol fermentation process, corn kernels and other grains are used, it provides nearly 50% of ethanol per dry weight of the grains. In the second-generation process, plant wastes have been used for the manufacture of bioethanol

Carbohydrates are found locked in wastes. The complex polysaccharides are converted into simple sugars. It is carried out by *Clostridium thermocellum*, *C.thermohydrosulphuricum*, *C.thermo-saccharolyticum*. The sugars are converted into ethanol by *Zymomonas nobilis*, *Thermoanaerobacter ethanolicus*, etc Some microbes produce ethanol directly from carbohydrate wastes. Eg. *Monilia*, *Fusarium*, etc.

Biochemistry of Ethanol Fermentation

The carbohydrates locked in the wastes are source of glucose. A glucose molecule is metabolized into two molecules of pyruvic acid through glycolytic pathway. The pyruvic acid is converted into ethanol in the following route:

The pyruvic acid is decarboxylated to acetaldehyde in the presence of carboxylase and thiamine pyrophosphate as a co-factor. The acetaldehyde is then reduced to ethyl alcohol by the enzyme alcohol dehydrogenase and NADH, as co enzyme.



Ethanol fermentation takes place under anaerobic conditions. The metabolism of ethanol from glucose was first explained with reference to yeast by Guy-Lussac in 1815. Later microbes are known to have this metabolic -route to produce ethanol.

Ethanol production involves the following steps-

1. Formulation of medium.
2. Designing of fermentation system
3. Culture of microbes in fermenters
4. Recovery of ethanol

1. Formulation of Medium

The sugar concentration of cane molasses and of other carbohydrates in the waste is diluted to 10-18%. This sugar concentration favors the growth of the microorganisms. Ammonium sulphate



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



or ammonium phosphate is added to the diluted medium. The pH of the medium is adjusted to 4-5 by using dilute sulphuric acid.

The starchy media like corn, rye and barley are hydrolyzed with dilute acids before they are pumped into the fermenter. The hydrolysis of starch yields simple sugars which are directly converted into ethanol.

Sometimes starchy feed stock is treated with amylase enzyme, extracted from *Aspergillus* and *Rhizopus*. Amylase converts the starch into 80% maltose and 20% dextrin that can easily be converted into glucose.

2. Designing of Fermentation System

The fermentation system consists of three molasses tanks, three seed tanks, a fermenter and a wash chamber. Among the three molasses tanks, one is larger in size. It is loaded with a large volume of molasses. It is named molasses storage tank.

The stored molasses enters another tank where the molasses is diluted properly with water. The diluted molasses then enters the sterilization tank for sterilization. The sterilized medium is used to carry out ethanol fermentation.

The seed tanks are rather smaller vessels which are interconnected by pipelines. Microbes are cultured in the seed tanks and supplied to the fermenter to carry out ethanol fermentation.

A fermenter is a large vessel to carry out ethanol production. It has three inlets at its top to receive sterilized medium from the sterilization tank, inoculum from seed tank and chemicals. It has an outlet at the base to harvest the broth. The fermenter is cooled by circulating cold water through a water jacket.

The fermenter is connected with a wash chamber by a pipeline. Harvested broth is transferred to the wash chamber for distillation.

3. Culture of Microbes in Fermenter

Sterilized medium in the sterilization tank is pumped into the fermenter, then microbial inoculum is pumped into the fermenter to carry out ethanol fermentation. Temperature inside the fermenter is regulated by circulating cold water through the water jacket for keeping the temperature at 33°C temperature which is found to be suitable for the fermentation. Ethanol fermentation is complete in about 3 days.

The enzyme invertase of *Zygomonas* (yeast) converts sucrose in the molasses into glucose. This glucose is converted into ethanol by the enzyme zymase.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



1. Ethanol is an active solvent of dyes, lubricants, adhesives, some pesticides, paints, explosives and resins. It is also used as an organic solvent for the extraction of some organic compounds from living things.
2. Ethanol is used in the manufacture of synthetic rubber.
3. It is used in the manufacture of syn-thetic fibers like rayon, polyester, etc.
4. It is used in the extraction of certain pharmaceutical products.
5. It is used in the manufacture of acetaldehyde.
6. It is used in the manufacture of perfumes.
7. Ethanol is used as fuel in internal combustion engines. It is used in anhydrous form (99.8% ethanol) or mixed with petrol or in the form of hydrated ethanol. In most cases, 15% or 10-20% of ethanol is mixed with petrol for fuel purpose in engines and in chemical industries. The energy contents of ethanol are 19 MJt.
8. In Brazil, nearly one-third of cars are running by consuming ethanol as fuel.
9. Americans use ethanol along with petrol for running their cars. They are marketing pet-rol along with ethanol.
10. India produces nearly 10 million hectolitres of ethanol per year. Ethanol fuel de-creases fuel economy to 15-30% over 100% gasoline.
11. Ethanol never releases smoke in the atmosphere while burning. Therefore, ethanol seems to be an ideal liquid fuel for the third world. While using ethanol as fuel the CO₂ emission is reduced from 100 to 56% in vehicles.

Bioethanol production from Algal source

Bioethanol is produced from algae by cultivating and harvesting the biomass, followed by pretreatment to break down cell walls, saccharification to convert carbohydrates into sugars, and finally, fermentation of these sugars by yeast to produce ethanol.

Why Algae?

- Fast growth rate
- High carbohydrate (starch/cellulose) content
- Can grow in wastewater or saltwater
- Do not need arable land
- High CO₂ absorption capacity



Types of Algae Used:

1. Green Algae (Chlorophyceae)

- Example: Chlorella, Scenedesmus

2. Blue-Green Algae (Cyanobacteria)

- Example: Spirulina

3. Red/Brown Algae (macroalgae in some cases)

Steps in Bioethanol Production:

1. Cultivation of Algae:

- Algae are grown in open ponds or photobioreactors using light, CO₂, and nutrients.

2. Harvesting:

- Algae biomass is harvested via flocculation, filtration, or centrifugation.

Goal: Separate algal biomass from water.

3. Pre-treatment:

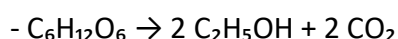
- Drying: To remove moisture.
- Mechanical: Ultrasonic, mechanical shear, etc.
- Enzymatic: Using enzymes to break down the cell walls
- Chemical: Using dilute acids like sulfuric acid
- Thermal: Applying heat to damage the cells
- Cell Disruption: Mechanical or chemical breakdown to release carbohydrates.

4. Saccharification:

The carbohydrates (starch, cellulose) are broken down into fermentable sugars. This can be done separately from fermentation or simultaneously, a process known as Simultaneous Saccharification and Fermentation (SSF) which can be more cost-effective.

5: Fermentation

- Microorganisms like *Saccharomyces cerevisiae* converts sugars into ethanol:



6: Distillation & Dehydration

- Distillation: Separate ethanol from fermentation broth.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



- Dehydration: Remove water to get anhydrous ethanol (fuel-grade).

Advantages of using algal sources

High carbohydrate content: Algae can be rich in carbohydrates like starch and cellulose, which are ideal for bioethanol production.

No lignin: Algae lack lignin and hemicellulose, structural biopolymers that make it difficult to produce bioethanol from other plant biomass.

Avoids land and food use competition: Algae cultivation doesn't compete with food crops for land.

Environmental benefits: Algal bioethanol production can have lower greenhouse gas emissions compared to some conventional methods.



Integration of system biology for agricultural applications

Introduction to Systems Biology

- Systems Biology is an interdisciplinary field that integrates biology, computer science, and mathematics to understand complex interactions in biological systems.
- It involves modelling entire biological systems (cells, organisms, ecosystems) rather than studying individual components in isolation.

This integration is used to develop "smart crops" with desired traits through genetic engineering by identifying key genes and pathways. It also optimizes resource use by improving fertilizer and water efficiency and helps manage pests and diseases more effectively.

Need in Agriculture

- Modern agriculture faces challenges such as climate change, pests, nutrient deficiency, and food security.
- Systems biology offers predictive models for crop improvement, stress resistance, and productivity enhancement.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Key Components Integrated

Genomics: DNA-level data of crops (e.g., genome sequencing).

Transcriptomics: Gene expression under different conditions.

Proteomics: Protein profiling for stress and growth.

Metabolomics: Study of metabolic changes in crops.

Phenotyping: Observation of physical traits.

Bioinformatics & Modelling: Integration and simulation.

Applications in Agriculture

Tools and Technologies Used

- High-throughput sequencing (NGS)
- Bioinformatics databases (e.g., KEGG, STRING)
- Machine learning for data prediction
- Software: Cytoscape, MATLAB, R, Python

Implementing Agricultural System Integration effectively often requires adopting specific “technologies and practices”. These might include:

Precision agriculture technologies GPS-guided machinery, variable rate applicators, sensors, and drones enable farmers to monitor and manage re-sources with greater precision, optimizing input use and reducing environmental impact in integrated systems.

Conservation agriculture practices → No-till farming, cover cropping, and crop residue management are crucial for enhancing soil health in integrated systems, reducing erosion, and improving water infiltration.

Integrated pest and nutrient management (IPNM) ← IPNM strategies minimize reliance on synthetic pesticides and fertilizers by utilizing biological control, crop rotation, and nutrient cycling within the system.

Renewable energy technologies → Integrating solar, wind, or biogas energy production into agricultural systems can reduce reliance on fossil fuels and create closed-loop energy systems on farms or in rural communities.

Water management technologies: Efficient irrigation systems, rainwater harvesting, and water recycling are essential for optimizing water use in integrated systems, especially in water-scarce regions.



Advantages

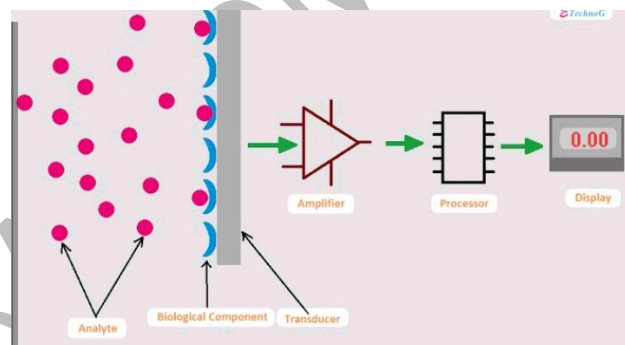
- Holistic view of plant systems
- Speeds up crop development
- Enhances sustainability and precision farming
- Helps in climate-resilient agriculture

Challenges

- Data integration complexity
- High cost of multi-omics technologies
- Need for skilled bioinformatics professionals
- Limited accessibility in small-scale farming

Biosensors in Agriculture Management

A biosensor is an analytical device that converts a biological response into an electrical signal. It consists of a biological recognition element (like an enzyme or antibody) that interacts with the analyte, a transducer that converts the biological interaction into a measurable signal, and a signal processing system that displays the results.



Biosensor

Agriculture includes the production of crops and rearing of livestock. These elements play a major role in our daily life. These products have always been disposed to damage in the form of pests and diseases. Hence, the need for early detection in agriculture field is necessary to prevent crop diseases, insect damage, weed infestations, water deficiency or surplus, flood management and measure of crop nutrition and plant populations etc. The agriculture industry has been for a long time dependent upon human expertise for quality control.

Biosensors in Organophosphorus:

Organophosphorus are the group of chemicals compounds that widely used as insecticides, pesticides and herbicides in modern agriculture for controlling a wide variety of insects, pests,



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



weeds and disease transmitting vectors. The concentration of insecticides, pesticides, herbicides and heavy metals in agricultural lands is increasing in day to day. This aspect contaminates the soil and environment and causes many health hazards to living organisms. Monitoring of the Organo phosphorus compounds is necessary in agricultural lands for healthy and sustainable development. Biosensors can play a major role in detecting and monitoring organo phosphorus levels in the soil and groundwater.

Biosensors in pesticides and its residues detection:

Pesticides are the most abundant compounds present in water, atmosphere, soil, plants and food. Public concern over pesticide residues has been drastically owing to the high toxicity and bioaccumulation effects of pesticides and the serious risks that they pose to the environment and human health. It is therefore crucial to monitor pesticide residues by using various analytical methods and techniques. Enzymatic sensors based on the inhibition of a selected enzyme are the most extensively used biosensors for the determination of the pesticides. Based on this principle various types of biosensors are used for the detection of pesticides. Immunosensors are biosensors that use antibodies or antigens as the specific sensing elements and provide concentration dependent signals. This detects and monitors pesticide residues in rapid speed. Electrochemical acetylcholinesterase (AChE) biosensors are simple, rapid and ultra-sensitive tools used to detect carbamate pesticides in fruits in vegetables. The pesticide biosensors were applied in the detection of carbaryl and methomyl pesticides in food samples. The AChE biosensor detects and analyses the carbaryl and methomyl concentrations in given samples. These biosensors were stable for a period of 2 to 120 days.

Biosensors for detection of Herbicides:

The biosensor measured and detects the herbicides (e.g., 2, 4 dichlorofenoxiacetic, diuron and paraquat) that inhibits photosynthesis in plants such as the phenyl urease and triazines etc. Photosystem 2 -based biosensors are used to detect photosynthetic herbicides.

Biosensors used for quantification of Nitrates in plants.

Two bacterial biosensors *Enterobacter cloacae* and *E. coli* detects the quantity of nitrate present in the soil and also the bacterial biosensors are useful to estimate the microbial niches in complex natural environments such as the rhizosphere.

Biosensors for detection of food pathogens and mycotoxins:

Biosensors are also used in food industry for detecting chemical pollutants, food-borne pathogens, microbes and food quantification in soft drinks etc. Optical biosensor detects the presence of *Salmonella* and *Typhimurium* in milk and apple juice within 45mins. Electrochemical magnetic biosensors are used for detecting salmonella bacteria in milk. Fluorometric biosensor detects and quantifies aflatoxins. These toxins are mostly found in agricultural products. Electrochemical antibody/enzyme detects aflatoxins B1 in spices and olive oil, aflatoxin M1 in milk.



Detection of pathogens in plants:

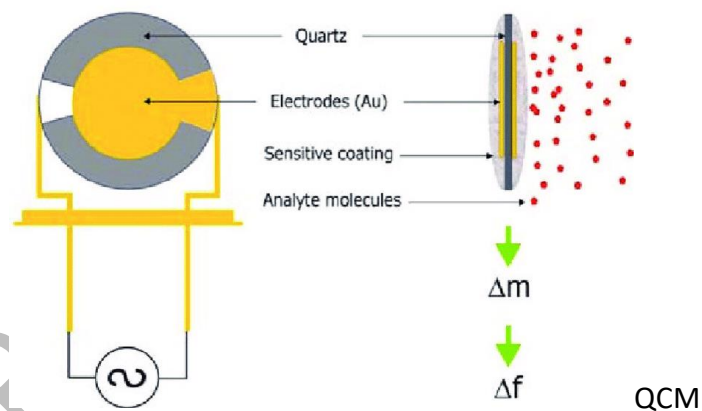
QCM (Quartz crystalline Micro balancer) biosensor or Acoustic-based biosensor detects plant pathogens like *Ralstonia solanacearum*, *Pseudomonas syringae* pv. tomato and *Xanthomata's campestris* pv. *vesicatoria*. In QCM or acoustic biosensor techniques DNA of the pathogens is directly used in QCM crystalline plate.

Piezoelectric effect: A QCM biosensor is built around a quartz crystal that exhibits the piezoelectric effect—it vibrates at a specific resonant frequency when an electric voltage is applied.

Mass detection: The crystal is coated with a receptor molecule (e.g., an antibody) designed to capture a specific target analyte. When the analyte binds to the receptor, it adds mass to the crystal's surface.

Frequency shift: This added mass causes a decrease in the crystal's resonant frequency.

Real-time monitoring: The change in frequency (Δf) is directly proportional to the change in mass (Δm) on the crystal's surface, allowing for real-time monitoring of binding events without the need for labels.





UNIT – III

ENTREPRENEURSHIP OPPORTUNITY IN INDUSTRIAL BIOTECHNOLOGY

Industrial biotechnology, at its core, is the use of living cells and biological systems to produce products that are cleaner, faster, and more sustainably produced while replacing petroleum-based processes with bio-based products like bioplastics, biofuels, and enzymes; agricultural applications such as biofertilizers and biopesticides; and environmental solutions like bioremediation and wastewater treatment. Other sectors include food processing, textiles, and the production of diagnostic kits and other specialized biological products.

Business opportunity in Industrial biotechnology

Business opportunities in industrial biotechnology include biomaterials like bioplastics, biofuels such as bioethanol, industrial enzymes for food and detergent production, and bio-based agricultural products like biofertilizers and biopesticides. Other areas include biopharmaceuticals, vaccine manufacturing, bioremediation, and diagnostic tools.

Biofuels Production

Biofuels are a renewable energy source derived from organic matter, known as biomass, such as plants, algae, and animal waste. They are a sustainable alternative to fossil fuels and can be produced in solid, liquid, or gaseous forms, though liquid biofuels like ethanol and biodiesel are commonly used in transportation. While biofuels offer environmental benefits like reduced greenhouse gas emissions compared to fossil fuels, concerns exist regarding their production costs and potential impacts on land and water resources.

Common types of biofuels

Ethanol: An alcohol fuel often blended with gasoline, typically made from corn, sugarcane, or other starchy crops.

Biodiesel: A fuel used in diesel engines, made from vegetable oils, animal fats, or recycled cooking grease.

Biogas: A gas that can be produced from the anaerobic digestion of organic waste and used for heating or electricity generation.

Business Potential

- Growing demand for renewable energy.
- Government subsidies and climate targets.
- Opportunity to create rural employment.

Bioplastics and Biopolymers



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Polymers produced by living organisms, such as polynucleotides (DNA/RNA), polypeptides (proteins), and polysaccharides (sugars). They can be derived from plants, animals, or microbes.

A type of biopolymer, or a plastic made from renewable biomass sources, that can be used as a substitute for traditional petroleum-based plastics. Primarily derived from renewable resources like corn starch, sugarcane, and vegetable oils.

i) Business opportunity

The growing demand for sustainable alternatives has created vast business opportunities in bioplastics manufacturing and product development. Entrepreneurs can explore production of biodegradable packaging films, bottles, and containers to extend shelf life and reduce plastic waste. There is a thriving market for eco-friendly disposable items like cutlery, coffee pods, and plates. The widespread use of PLA in 3D printing opens avenues in the tech and prototyping industries. Additionally, biopolymers offer opportunities in textile manufacturing for producing sustainable fibers used in clothing and carpets. In the healthcare sector, bioplastics can be developed for controlled drug delivery systems and biodegradable medical implants such as those used in bone grafting and tissue engineering, offering a high-value niche market.

Enzyme production

Microbial production of industrial enzymes is a process that uses fermentation, primarily with fungi and bacteria, to generate enzymes at a large scale. This method is preferred over plant and animal sources due to lower costs, faster growth rates, and easier genetic modification to improve enzyme yield and performance.

Fungi: *Aspergillus* species are widely used to produce enzymes like amylase, cellulase, and protease.

Bacteria: *Bacillus* species are a major source for enzymes such as amylase, protease, and glucose isomerase.

Yeast: Yeasts are also used, particularly for producing enzymes like invertase and for fermentation in beverage production.

Business Opportunities

The diverse applications of enzymes across industries present profitable business opportunities for entrepreneurs in industrial biotechnology. There is strong demand for enzyme-based detergents, which help break down stains like starch and fats in laundry and dishwashing products. The textile industry offers scope for enzymes used in fabric desizing, softening, and whitening. In leather processing, enzyme solutions can replace harsh chemicals, creating eco-friendly tanning processes. The dairy sector relies on enzymes for cheese production, presenting opportunities in specialty enzyme formulation. Baking industries seek enzymes that enhance dough handling, improve bread texture, and extend shelf life. In brewing and winemaking, enzymes support efficient fermentation, creating openings for supply of fermentation aids.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Moreover, the production of sweeteners like high-fructose corn syrup through enzymatic processes provides a valuable niche in the food processing sector.

Bioremediation

Bioremediation is a process that uses biological organisms, such as microbes and plants, to clean up or remove environmental pollutants from soil, water, and air. These organisms break down harmful contaminants into less toxic or non-toxic substances like carbon dioxide and water. Techniques can involve stimulating the growth of existing microbes by adding nutrients or introducing new ones with specialized pollutant-degrading properties.

Business opportunity

Bioremediation offers promising business potential in addressing environmental pollution through microbial technologies. One key opportunity lies in oil spill management, where specialized microbes can degrade hydrocarbons, creating a market for microbial consortia and cleanup services. Contaminated soil and groundwater remediation using microbes to neutralize pesticides, solvents, and industrial chemicals is another growing sector, especially around industrial zones. Additionally, with increasing focus on sustainability, biodegradation of plastic pollution using engineered microbes or enzymes presents an emerging niche, offering scope for start ups and enterprises in eco-friendly waste management and environmental restoration solutions.

ii) Essential requirement

The essential requirements for an entrepreneurship opportunity in industrial biotechnology combine a unique blend of strong scientific knowledge, robust business acumen, significant capital, and the ability to navigate complex regulatory landscapes. Success hinges on translating a novel scientific idea into a commercially viable product that addresses an unmet market need.

1. Scientific & Technical Knowledge

- Strong background in biology, microbiology, genetic engineering, or biochemistry.
- Understanding of industrial processes like fermentation, enzyme technology, or bioreactor operation.
- The venture must be built around a novel, potentially patentable idea or technology that offers a superior solution to existing problems in sectors like chemicals, energy, food, or textiles.

2. Infrastructure & Equipment

- Lab-scale setup for R&D.
- Pilot-scale or industrial production facilities (e.g., fermenters, bioreactors, sterilization units).
- Quality testing equipment.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



3. Raw Materials & Strains

- Access to high-quality microbial/plant strains, feedstock (e.g., biomass, agro-waste), and chemicals.

4. Regulatory Compliance

- The industry is heavily regulated to ensure safety and ethical standards.
- Approvals from bodies like FSSAI, CPCB, BIS, or FDA (for biotech food/pharma products).
- Adherence to biosafety, environmental, and patent regulations.

5. Skilled Workforce

- Biotechnologists, process engineers, QC analysts, and marketing professionals.
- A successful venture requires a balanced team with expertise spanning science, business, and regulatory affairs. Essential personal characteristics for the entrepreneur include:
- Strong leadership and communication skills to inspire a team and attract investors.
- Resilience, persistence, and adaptability in the face of setbacks.

6. Research & Innovation Capability

- Focus on process optimization, innovation in bio-products, or development of eco-friendly technologies.

7. Funding & Financial Planning

- Initial investment through government schemes (e.g., BIRAC, MSME), venture capital, or bank loans.
- Entrepreneurs must be adept at securing funding from diverse sources such as:
- Venture Capital (VC) firms and angel investors.
- Government grants and support programs (e.g., BIRAC initiatives in India).
- Partnerships with corporations and academic institutions.
- Budgeting for production, R&D, certification, and marketing.

8. Market Understanding

- Knowledge of target industries: food, agriculture, pharma, packaging, waste management, etc.
- Competitor analysis and customer need identification.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



- Developing a robust plan with clear financial projections, cost structures, and revenue streams.
- Managing both scientific uncertainties and business risks, which are often higher in biotech due to lengthy development timelines.

9. Business & Marketing Strategy

- Clear business plan with branding, pricing, and distribution channels.
- Digital and offline marketing for product promotion.

10. Intellectual Property (IP) Management

- Patenting novel strains, processes, or products for business protection and licensing opportunities.

Marketing strategy

1. Pharmaceuticals

Role of Industrial Biotech:

- Uses microbes and enzymes to produce antibiotics, vaccines, hormones (like insulin), and therapeutic proteins through fermentation.
- Enables large-scale biomanufacturing of drugs with higher purity and fewer side effects.

Market Need:

- Demand for cost-effective, safer, and eco-friendly drug production.
- Increasing use of biosimilars and biopharmaceuticals.

2. Agriculture

Biotech Solutions:

- Biofertilizers: Replace chemical fertilizers by enhancing nitrogen fixation (e.g., Azotobacter, Rhizobium).
- Biopesticides: Natural agents (like *Bacillus thuringiensis*) that control pests without harming the environment.

Market Demand:

- Rising awareness of organic farming.
- Government subsidies promoting sustainable agriculture.



3. Biofuels

Biotech Use:

- Microorganisms convert biomass, algae, or waste into ethanol, biodiesel, and biogas.
- Example: Algal biofuel is a renewable alternative with high oil yield.

Growing Market:

- Energy crisis and climate change drive the need for cleaner fuels.
- Supported by national bioenergy policies (e.g., India's Ethanol Blending Programme).

4. Food & Beverage

Biotech Applications:

- Enzymes (e.g., amylases, proteases) used in brewing, baking, dairy, and fruit juice clarification.
- Improve shelf life, taste, and texture.

Why It Matters:

- Consumer preference for clean-label, preservative-free, and natural foods.
- Growing functional foods and nutraceuticals market.

5. Textiles

Biotechnological Use:

- Enzymatic desizing, biopolishing, and bleaching reduce chemical usage.
- Enzymes replace harsh acids/alkalis, making textile processing eco-friendly.

Market Potential:

- Textile industry seeks greener solutions due to environmental norms.
- Appeals to brands focusing on sustainable fashion.

6. Environmental Sector

Biotech Applications:

- Bioremediation: Use of microbes to clean oil spills, heavy metals, and industrial waste.
- Wastewater treatment: Activated sludge systems with engineered microbes.

Importance:

- Industries under pressure to reduce pollution.



- Municipalities and governments investing in biotech-based clean-up solutions.

Unique Value Proposition (UVP)

What is a Unique Value Proposition (UVP)

A UVP is a clear statement that describes:

- What makes your product or service valuable,
- How it is different or better than competitors (especially traditional chemical industries),
- Why customers should choose you.

1. Eco-Friendly and Biodegradable Alternatives

Core Benefit:

- Industrial biotech uses biological organisms or systems instead of synthetic chemicals, reducing pollution.

Examples:

- Bioplastics (e.g., PLA) that decompose naturally.
- Enzyme-based detergents that are safer for aquatic life.

Customer Value:

- Appeals to eco-conscious consumers and industries aiming for green certifications.
- Helps industries meet environmental regulations.

2. Cost-Effective in the Long Run

How It Saves Costs:

- Reduces waste treatment costs (due to lower toxicity).
- Less energy usage (e.g., enzyme reactions often work at ambient temperatures).
- Increases efficiency and yield in production processes.

Example:

- In textile processing, enzyme desizing saves water, energy, and time.

Brand Positioning

Position your brand as a:

- Pioneer in Sustainable Innovation: Showcase your commitment to environmentally responsible technologies that align with circular economy principles.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



- Trusted Provider of Advanced Biotech Solutions: Emphasize quality, reliability, and scientific excellence in your products and services.
- Future-Oriented Brand: Align your mission with global sustainability goals such as the UN Sustainable Development Goals (SDGs) and Environmental, Social, and Governance (ESG) standards.

Digital Marketing

Use online platforms to reach wider audiences:

- Website: showcase products, research, certifications
- Social Media: share success stories, customer feedback
- Content Marketing: blogs and videos on biotech trends
- SEO & Ads: improve visibility in biotech-specific searches

Customer Education

Since biotech is technical, educate your customers:

- Workshops and demos to show practical use
- Webinars on product benefits
- Tutorials & case studies

Educated customers are more likely to adopt new technology.

After-Sales Support

- Provide reliable support through:
- Training for usage & maintenance
- Customer helplines for troubleshooting
- Regular follow-ups to ensure satisfaction

Schemes

Agricultural Biotechnology and Industrial Biotechnology share some common schemes, but also have specific ones based on their focus areas. The schemes (NABARD, RKVY-RAFTAAR and ICAR-Agribusiness Incubation (ABI) are available in agriculture are also applicable to industrial biotechnology in some cases.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



1. PMFME – Pradhan Mantri Formalisation of Micro Food Processing Enterprises

Aim:

To support micro food processing units, particularly those using local resources and traditional techniques.

Relevance to Industrial Biotech:

- Supports fermentation-based biotech industries (e.g., probiotics, enzymes, organic acids).
- Encourages value-added food biotech (e.g., nutraceuticals, functional foods).

Key Features:

- Credit-linked subsidy (35% up to ₹10 lakhs).
- Support for branding, marketing, and packaging.
- Training on food safety standards (like FSSAI, GMP).
- Assistance in upgrading technology for small-scale processors.

2. TIDE 2.0 – Technology Incubation and Development of Entrepreneurs

Implemented by: Ministry of Electronics and Information Technology (MeitY)

Focus:

To promote tech-based start ups, including those combining biotech with IoT, AI, or biosensors.

Relevance to Industrial Biotech:

- Encourages biosensor start ups, smart monitoring for fermentation, enzyme activity.
- Supports biotech + digital innovations for diagnostics, waste management, etc.

Key Benefits:

- Grants up to ₹7 lakhs for ideation-stage start ups.
- Incubation support at MeitY-approved centres.
- Access to mentorship, lab space, and market linkages.

3. TDB – Technology Development Board (DST)

Aim:

To commercialize innovative and scalable technologies developed by Indian entrepreneurs and research institutions.

Relevance to Industrial Biotech:



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



- Funds pilot-scale production and scale-up of biotech innovations.
- Ideal for enzyme production units, bioplastics, biofuels, fermentation industries.

Key Features:

- Soft loan or equity up to 50% of project cost.
- Focus on industrially viable biotech products.
- Preference for projects that are eco-friendly, sustainable, and import substitutes.

Summary:

These schemes empower industrial biotech start ups to innovate, scale up, and compete in the market with funding, technical, and incubation support. Tailoring applications to align with scheme objectives is key to approval.

Challenges

Scaling up

One of the biggest challenges facing industrial biotechnology is scaling up from lab-scale to commercial-scale production. This often requires significant investment in process design, engineering, and validation, which can be costly and time-consuming. Additionally, the scalability of a given process depends on the biological system being used, and some systems may be challenging to scale up due to technical, environmental, or regulatory constraints.

Uncertainty about market conditions

Another challenge for industrial biotechnology is the uncertainty surrounding market demand and product acceptance. While bio-based products are gradually being adopted in many sectors, other traditional chemical or fuel products remain dominant, and their demand may continue to increase. Therefore, developing bio-based products that can compete with conventional products in terms of price, performance, and reliability is a crucial challenge for industrial biotechnology. It will require collaboration between public and private stakeholders and significant investment in research and development to overcome this challenge.

Intellectual property rights (IPR)

The development of new microbial strain or metabolic pathway for bio-based production requires substantial research investment. Therefore, protecting intellectual property rights in industrial biotechnology must be considered. The biotech industry is characterized by complex and sometimes opaque intellectual property systems, which can hinder the development and commercialization of new products. In addition, the patent system-imposed barriers to entry for small businesses and research institutions, limiting competition and increasing the concentration of the industry.



Energy intensity

Another significant challenge for industrial biotechnology is the high energy intensity of some bio-based production processes. Fermentation processes are energy-intensive, requiring a steady flow of temperature and oxygen during industrial processing. The energy intensity of bio-based production can limit the potential environmental benefits of using renewable resources because of the increased energy consumption associated with bioprocessing.

Pollution monitoring

Pollution monitoring is the systematic tracking and measurement of pollutants like smog, particulate matter, and chemical toxins in the air, water, and soil to assess environmental quality and health risks. The data is crucial for informing policy, protecting public health, and helping individuals make informed decisions to reduce exposure to pollutants.

1. Air Pollution Monitoring Methods

a) Continuous Ambient Air Quality Monitoring Systems (CAAQMS)

A Continuous Ambient Air Quality Monitoring System (CAAQMS) is an automated setup that continuously measures and reports on pollutants like (CO), (NO), (SO₂), (O₃) and particulate matter (PM) in real time. These systems use sensors and analyzers to collect data that is transmitted to a central database for analysis, which helps in identifying pollution sources, assessing control measures, ensuring regulatory compliance, and informing public health initiatives.

- Uses: Urban air quality networks, industrial areas.

Enables the early detection of pollution events and the assessment of the effectiveness of control strategies.

- Example: CPCB monitoring stations in Indian cities.

b) Passive Sampling

Passive sampling for air quality is a method that uses devices to collect air pollutants without a mechanical pump, relying instead on natural diffusion.

- Duration: Usually over days or weeks.

- Use: Long-term exposure monitoring, low-cost studies.

Passive samplers are simple to operate, easy to transport, and do not require external power.

c) Active Sampling

Active sampling for air quality involves using a pump to draw a known volume of air through a collection device, such as a filter or agar plate, for more accurate and faster results compared to passive methods. This technique is used to assess air quality for particulates, biological contaminants (like mold and bacteria), or gases and vapors. The collected sample is then analyzed



to determine the concentration of pollutants, providing quantitative data for environmental monitoring.

- Analysis: Filters analyzed in labs for pollutants.
- Used for: Accurate short-term measurements.

Can detect lower concentrations of pollutants.

d) Remote Sensing

Remote sensing is the process of gathering information about an object or phenomenon from a distance without physical contact, typically using sensors on aircraft or satellites. It works by detecting and measuring reflected or emitted radiation (like light or heat) from a target, such as the Earth's surface.

Satellites (like NASA's MODIS) or drones detect atmospheric pollutants.

- Benefits: Large-area coverage, inaccessible regions.
- Limitation: Less precise than ground sensors.

2. Water Pollution Monitoring Methods

a) Grab Sampling

Grab sampling is the process of collecting a single sample from a fluid or gas source at a specific time and location for later laboratory analysis. Also known as catch sampling or spot sampling. The sample is collected using a scoop, bottle, or a specialized closed-loop system.

The sample is then transported to a laboratory for analysis.

Advantages

Simple and flexible: It often requires less equipment and allows for flexible selection of sampling locations.

Cost-effective: In many situations, grab sampling is less expensive than other methods like continuous online analyzers.

Limitations

Variability: The sample can be affected by temporal or spatial variations that occur between sampling events.

Bias: The results can be biased depending on the location and timing of the sample collection.

b) Composite Sampling

Composite sampling is a technique where multiple individual samples are combined and mixed into a single, representative "composite" sample for analysis. This method reduces the number of

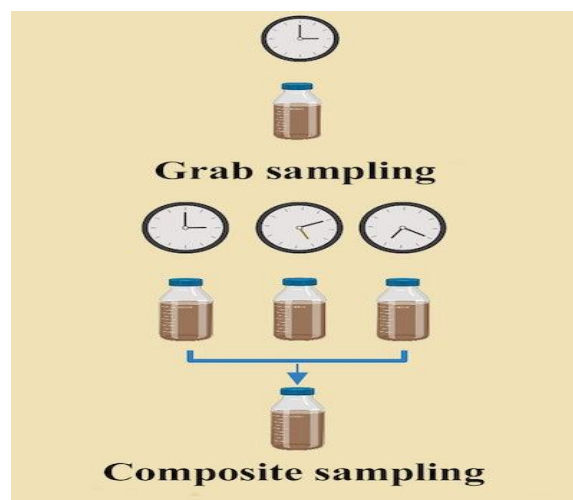


analyses needed, saving costs, while still providing a reliable overview of the entire area or batch being tested. It is commonly used in environmental studies (like soil or water testing) and industrial quality control.

Limitations

Loss of information on individual samples: You cannot determine the specific values of the original individual samples, such as a single unusually high value.

Can be modified: In some cases, modifications can be made to retrieve information on individual samples that may be lost due to compositing.



c) Automated Water Samplers

A water and wastewater autosampler is a cornerstone of modern analytical instrumentation. It automates the process of sample collection for introduction into analytical systems.

- Useful for: Monitoring during rainfall or industrial discharge.

By eliminating human variability in the sampling process, autosamplers deliver exceptional precision and reproducibility.

By eliminating human variability in the sampling process, autosamplers deliver exceptional precision and reproducibility.

d) In-Situ Sensors

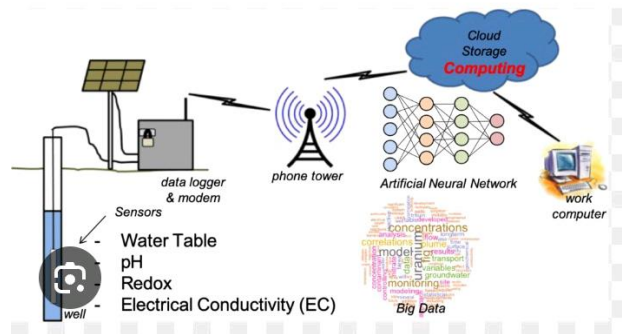
In-situ sensors are devices that perform measurements directly within the environment or subject of interest, without needing to take a sample and bring it to a lab. This method provides high-resolution, real-time data for applications like environmental monitoring, water quality testing, and space exploration.



Advantages

In situ probes can measure various parameters like temperature, turbidity, dissolved oxygen, and nitrate levels directly in aquatic environments.

Space research: Instruments with in situ sensors are used for characterization of planetary samples and the space environment.



e) Biological Monitoring (Bioindicators)

Biological monitoring in water quality uses living organisms, such as macroinvertebrates, fish, and algae, to assess the health of aquatic ecosystems. These organisms act as biological indicators, providing an integrated picture of water quality.

Common biological indicators

Aquatic macroinvertebrates: Small animals that live in water, such as insects and worms. They are frequently used because they are relatively easy to collect and identify.

Fish: The diversity, abundance, and health of fish populations can be indicators of water quality.

Algae: The growth and type of algae can indicate nutrient enrichment in the water.

Plants: Certain aquatic plants can also be used as indicators for specific pollutants.

Advantages

Long-term effects: It shows the long-term, cumulative effects of pollution, not just a snapshot in time.

Cost-effective: In some cases, it can be a more cost-effective tool, especially for assessing the cumulative impact of pollution in large river systems.

3. Soil Pollution Monitoring Methods

a) Soil Sampling & Laboratory Analysis

Soil sampling and analysis is a four-step process: collecting representative samples, preparing them by drying and grinding, conducting laboratory tests for properties like pH and nutrient levels, and interpreting the results to make informed management recommendations. Careful



sampling ensures the lab results accurately reflect the soil's condition, Analyze for key properties: The lab will test for a range of properties, including:

pH (acidity/alkalinity)

Nutrient levels (Nitrogen, Phosphorus, Potassium, etc.)

Organic matter content

Soil texture (sand, silt, clay content)

Other tests may include salinity or heavy metal analysis.

b) Spectroscopic Techniques

- XRF (X-Ray Fluorescence): Detects metals quickly in soil samples.

- FTIR (Fourier-Transform Infrared Spectroscopy): Detects organic pollutants.

c) Remote Sensing and GIS

Remote sensing is the process of collecting information about Earth's surface without physical contact, typically using sensors on satellites or aircraft. Geographic Information System (GIS) is a computer system that captures, stores, analyzes, and displays this spatial data. Together, remote sensing and GIS are powerful tools for analyzing geographical information.

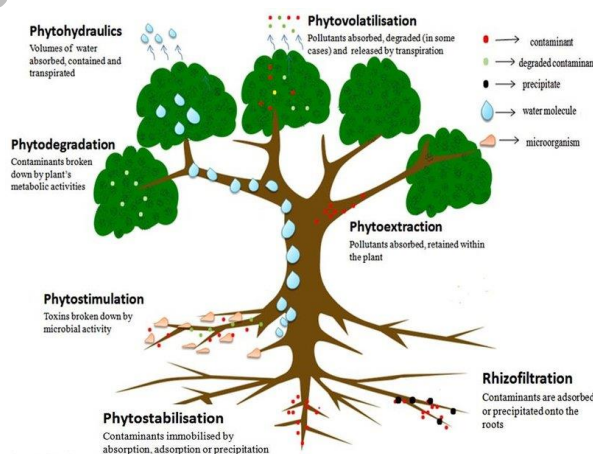
- Use: Identifies pollution spread using satellite data + mapping software.

- Useful for: Monitoring mining areas, oil spills, large-scale contamination.

d) Phytoremediation Indicators

- Method: Phytoremediation indicators are the characteristics or factors used to assess the success of a phytoremediation project, such as plant-based factors like biomass and deep root structure.

- Example: Mustard plants for heavy metal absorption.





Scope of Pollution Monitoring

- Environmental Protection
- Public Health Safety
- Industrial Regulation
- Urban & Rural Planning
- Climate Change Studies
- Public Awareness

Bioremediation for industrial pollutants

Bioremediation is a biotechnical process which involves the removal of complex material or contamination by degrading environmental pollutants using living micro-organisms.

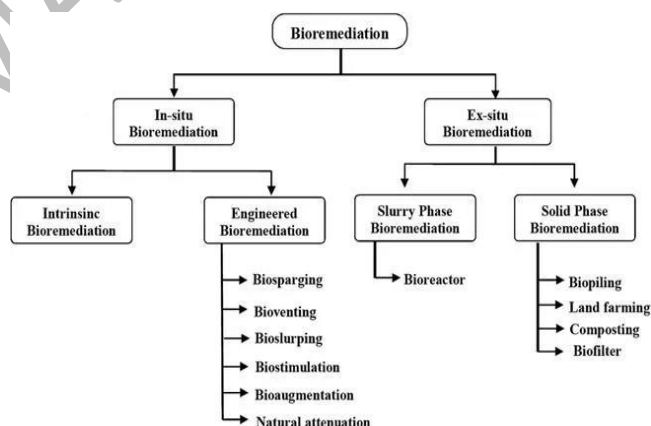
It is a technique to eliminate pollutants from the environment, restoring contaminated sites and avoiding future pollution.

Bioremediation activity relies on natural capacity of micro-organisms to degrade organic compounds.

The ability of micro-organisms could be enhanced by providing optimum growth conditions to micro-organism or by employing the genetically modified micro-organisms (GMMs). This technology has been implemented to eradicate environmentally hazardous chemicals and detoxify them into nontoxic forms.

Micro-organisms play vital role in bioremediation, several members of microbial group like algae, fungi and bacteria are able to solubilize, transport and deposit the metals, and detoxify dyes and complex chemicals.

The toxic waste materials are present in form of vapor, liquid or solid phases; therefore, bioremediation technology differs depending upon nature of toxic material.





In Situ Bioremediation

A technology for in situ treatment involves treating contaminated material in its location. The technologies bio stimulation, bioaugmentation, and bioventing are examples of in situ technology. Clearly, bioremediation has a number of benefits over standard physicochemical remediation techniques (pump and treat, landfilling, etc.).

These methods involve treating polluted substances at the source of pollution.

It requires no excavation and minimal or no soil disturbance during construction.

These procedures ought to be more cost-effective than ex-situ bioremediation techniques.

Some in-situ bioremediation procedures, such as bioventing, biosparging, and phytoremediation, may be improved, while others, such as intrinsic bioremediation and natural attenuation, may continue without modification.

Sites polluted with chlorinated solvents, heavy metals, dyes, and hydrocarbons have been satisfactorily remedied using in-situ bioremediation approaches.

There are two types of in situ bioremediation:

- i) Intrinsic in situ bioremediation
- ii) Engineered in situ bioremediation.

i. Intrinsic in situ bioremediation:

Intrinsic bioremediation is the process of converting environmental pollutants into the non-toxic forms through the inherent abilities of naturally occurring microbial population.

This process is most effective in the soil and water as these biomes always have high chance of being fully contaminated by contaminants and toxins.

This process is usually employed in underground places as such underground petroleum tanks.

There is escalating attention on intrinsic bioremediation for control of all or some of the contamination at waste sites.

The natural ability of micro-organisms to degrade the contaminants should be examined and tested at laboratory and in field trails prior its use for intrinsic bioremediation.

There are several conditions of site that promotes intrinsic bioremediation.

These conditions are:-

Flow of ground water throughout the year

Carbonate minerals to buffer acidity produced during biodegradation

Dispense of electron acceptors and nutrients for microbial growth



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Absence of toxic compounds

The other environmental factors such as pH, concentration, temperature and nutrient availability decides whether or not biotransformation takes place.

The microbial growth during bioremediation of the waste is hindered by presence of metals such as Hg, Pb, As and cyanide at toxic concentration.

Degradation of pollutants using bacteria in ground water relies on the type and concentration of compounds, electron acceptor and time period for which bacteria was exposed to contamination.

Therefore, capacity of bacteria used to degrade contaminants must be determined in laboratory by microbial studies prior to use.

ii. Engineered/accelerated in situ bioremediation:

Despite the good results, intrinsic bioremediation may not be suitable when site conditions are not matching with the microbial growth requirement.

It is because, intrinsic bioremediation is a slow process as growth and availability of micro-organisms are not adequate, there is limited capacity of electron acceptor and nutrients, cold temperature and high concentration of contaminants.

In these conditions, engineered in situ bioremediation is employed.

Engineered in situ bioremediation accelerates the desired biodegradation reactions by enhancing growth of more micro-organisms under optimum physico-chemical growth conditions. Oxygen and electron acceptors (e.g., NO_3^- and SO_4^{2-}) and nutrients (e.g., nitrogen and phosphorus) increase microbial growth in surface.

Advantages of in-situ bioremediation

Methods of in-situ bioremediation do not involve the excavation of contaminated soil.

This approach treats both dissolved and solid pollutants using volumetric treatment.

Frequently, expedited in-situ bioremediation can cure subsurface pollutants more quickly than pump-and-treat techniques.

It may be possible to convert all organic pollutants into harmless substances such as carbon dioxide, water, and ethane.

It is a cost-effective solution because site disruption is minimized.

Ex Situ Bioremediation

Ex-situ bioremediation approaches entail excavating pollutants from contaminated locations and moving them to a new location for treatment.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Ex-situ bioremediation procedures are frequently evaluated based on the depth of contamination, kind of pollutant, level of contamination, cost of treatment, and geographic location of the contaminated site.

Additionally, performance guidelines govern the selection of ex-situ bioremediation procedures.

On the basis of phases of contaminated materials under treatment ex situ bioremediation is classified into two parts as per following:

- i) Solid-phase system (involving land treatment and soil piles), i.e., composting.
- ii) Slurry-phase systems (including treatment of solid-liquid suspensions in bioreactors).

Solid-phase treatment

Solid-phase bioremediation is an ex-situ process that involves the excavation and piling of contaminated soil.

It also comprises domestic, industrial, and municipal trash, as well as organic wastes such as leaves, animal dung, and agricultural wastes.

Pipes are utilized to transport bacterial growth throughout the piles.

Ventilation and microbial respiration require air to flow through the pipes.

In comparison to slurry-phase procedures, solid-phase systems necessitate a vast amount of area and require more time to clean up.

Solid-phase treatment methods include bio piles, windrows, land farming, and composting, among others.

Slurry-phase bioremediation

Slurry-phase bioremediation is a somewhat faster treatment method than the others.

In the bioreactor, contaminated soil is blended with water, nutrients, and oxygen to produce the optimal environment for microorganisms to breakdown soil pollutants.

This procedure involves separating rocks and debris from contaminated soil.

The concentration of additional water is dependent on the quantity of contaminants, the rate of biodegradation, and the physicochemical parameters of the soil.

Using vacuum filters, pressure filters, and centrifuges, the soil is extracted and dehydrated following this procedure.



Integrated compost production

Definition:

Integrated compost production is a sustainable method of producing compost by combining different organic wastes and composting techniques (aerobic, anaerobic, vermicomposting, and microbial enrichment) to enhance the speed, quality, and nutrient value of compost.

1. Raw Materials Used:

- Plant residues: Crop waste, leaves, weeds
- Animal waste: Cow dung, poultry droppings, goat manure
- Household waste: Kitchen scraps, vegetable peels
- Agro-industrial waste: Bagasse, press mud
- Others: Straw, sawdust, green manure

2. Composting Techniques Integrated:

a) Aerobic Composting

- Organic matter decomposed in presence of oxygen
- Requires turning for aeration
- Fast process, low odor

b) Anaerobic Composting

- In pits, no oxygen
- Slower, produces biogas
- Useful for wet waste like slurry

c) Vermicomposting

- Uses earthworms (*Eisenia fetida*)
- Worms digest organic matter and excrete nutrient-rich castings
- Enhances compost texture and nutrient content

d) Microbial Enrichment

- Addition of microbial cultures (e.g., decomposer consortia, *Azotobacter*, PSB)
- Speeds up decomposition
- Improves NPK value



3. Process Steps:

1. Shredding: Cut large waste into smaller pieces
2. Layering: Alternate layers of dry (carbon-rich) and wet (nitrogen-rich) material
3. Moisture Management: Maintain 50–60% moisture
4. Inoculation: Add cow dung slurry or decomposer microbes
5. Turning: Regular mixing for aeration (in aerobic methods)
6. Earthworm Introduction (optional): After partial decomposition
7. Maturation: Let compost cure for 2–3 weeks before use

4. Compost Enrichment:

To improve compost value, the following may be added:

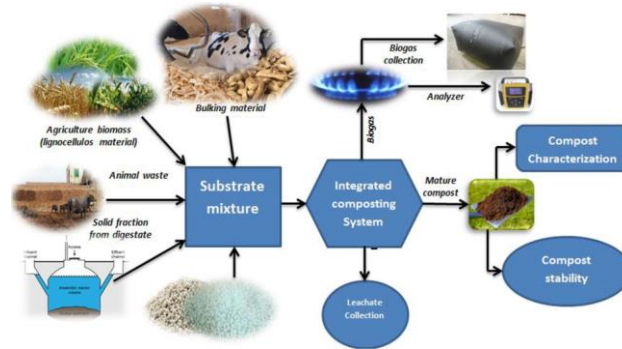
- Rock phosphate – for phosphorus
- Biofertilizers – Azospirillum, Rhizobium
- Micronutrients – Zinc, Boron, etc.

5. Benefits of Integrated Compost Production:

- Faster decomposition
- High nutrient content (NPK)
- Improves soil fertility and structure
- Low-cost and eco-friendly
- Reduces landfill waste
- Supports organic farming

Conclusion

Integrated composting is an effective and sustainable approach that combines the strengths of multiple composting methods to produce nutrient-rich compost suitable for agriculture, horticulture, and home gardening.



Microbe-Enriched Compost

Microbe-enriched compost is compost that has been inoculated with beneficial microorganisms (like biofertilizers or decomposers) to enhance its nutrient content, improve soil health, and promote plant growth.

1. Microbes Used in Enrichment:

- Nitrogen-fixing bacteria:
Azotobacter, Azospirillum, Rhizobium
- Phosphate-solubilizing bacteria (PSB):
Bacillus megaterium, Pseudomonas striata
- Potassium-solubilizing bacteria (KSB)
- Decomposer microbes:
Fungi and actinomycetes that break down organic matter faster
- Trichoderma spp. (for disease resistance)

1. Prepare Well-Decomposed Compost

- Use compost that is fully decomposed (dark, crumbly, earthy smell).
- It can be from plant residues, animal waste (like cow dung), or kitchen waste.
- Make sure the compost is mature to avoid harming the microbes added later.

2. Adjust Moisture to 40–50%

- The compost should be moist but not wet.
- To check: When you squeeze it in your hand, it should feel damp, and a few drops of water may come out, but it should not drip.
- Moisture is important for microbial survival and activity.



3. Add Microbial Culture (Biofertilizer)

- Select suitable microbial cultures like:
Azotobacter or Azospirillum – for nitrogen fixation
PSB (Phosphate Solubilizing Bacteria) – for phosphorus availability
Trichoderma – for disease suppression
- Dose: Generally, 1–2 kg of culture per ton of compost (or as per manufacturer's instruction).
- Mix the culture evenly into the compost to ensure uniform distribution.

4. Cover and Incubate for 7–10 Days in Shade

- Place the enriched compost in a shaded area to avoid direct sunlight (which can kill microbes). Cover loosely with jute bags or plastic sheets to retain moisture and maintain temperature.
- Incubation helps microbes to multiply and colonize the compost.

5. Turn the Compost Regularly

- Mix the compost every 2–3 days to:
Maintain uniform microbial growth
Ensure proper aeration
Prevent overheating or foul smell
- Aeration is important for aerobic microbes to stay active.

6. Curing and Field Application

- After 7–10 days of incubation, let the compost cure (stabilize) for another 3–5 days.
- Final compost should have:
Pleasant smell
Fine texture
Good microbial activity
- Apply it in fields at 1–2 tons/acre depending on crop needs.

Advantages:

- Enhances nutrient content (especially N, P, K)



- Improves microbial activity in soil
- Boosts plant growth and yield
- Helps in pest and disease suppression (e.g., *Trichoderma*)
- Environment-friendly and cost-effective
- Used in organic farming
- Applied in nurseries, kitchen gardens, and agriculture
- Helps reclaim degraded soils

5. Storage and Shelf Life:

- Should be stored in a cool, shaded place
- Use within 3–6 months for best microbial activity

Biopesticides production

Pests are insects which are damaging crop plants and stored products. The elimination of pests by using their natural enemies such as predators, parasites and pathogens is known as biological control of pests or biocontrol of pests.

Bacterial Pesticides

The formulation containing a suitable species of bacteria that kills pests, is known as bacterial pesticide. Many bacteria are known for their pest control activity. They cause characteristic diseases to pests so that the pests die. The pest population is kept in control due to severe infection. Bacteria such as *Bacillus thuringiensis*, *Bacillus popilliae* and *Bacillus lentimorbus* are used as bacterial pesticides.

a. Bacillus thuringiensis: It is a gram-positive, rod-shaped, soil-borne bacterium. It produces a single endospore inside the cell. It produces exotoxins and endotoxins. Such as α -endotoxin, β -endotoxin, γ -endotoxin and δ (delta)-endotoxin. Among them, delta endotoxin plays a key role in pest control. It occurs as a crystal of glycoprotein at one end of the endospore.

The β -endotoxin is a crystalline molecule composed of adenine, ribose sugar and glucose. Hence it is said to be a glycoconjugate of adenine nucleoside. The C1 of ribose is covalently linked with N9 of adenine. The C5 of the ribose is C4 of the glucose molecule. The C1 of the glucose is linked with a lipid.

When the bacterial cell enters an insect, the cell wall ruptures and the endospore comes out. The endotoxin gets dissolved in alkaline juice of digestive tract of the insect. The toxicity of the endotoxin kills the insect very soon. As a result the pest population is reduced greatly.



ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS



B. thuringiensis is mass cultured using cane molasses and delivered in the form of wettable powder or liquid suspension. It has been produced in almost all countries in the world since 1960. It is a broad-spectrum biopesticide. It is used to destroy –

- i. Cabbage worm (*Pieris rapae crucivora*)
- ii. Tobacco budworm (*Heliothis virescens*)
- iii. Japanese tussock moth (*Orgyia thyellina*)
- iv. Cotton bollworm (*Heliothis zea*)
- v. Gypsy moth (*Lymantria dispar*)
- vi. Colorado potato beetle (*Leptinotarsa decemlineata*)

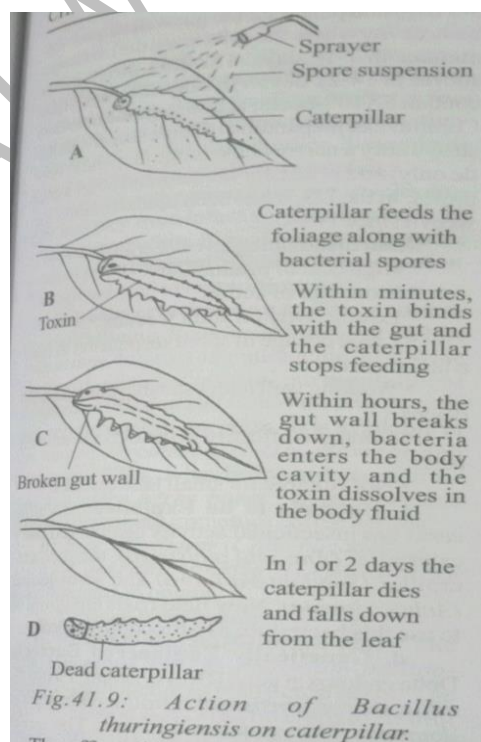
Vectors of human pathogens like *Culex* fly, *Aedes* and *Anopheles* are also controlled by this bacterium.

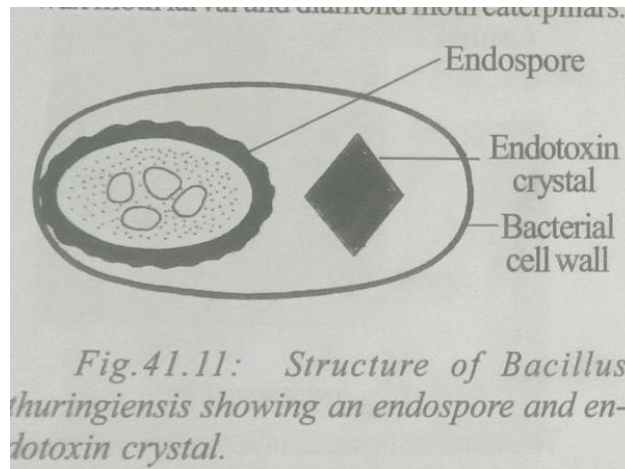
- *Bacillus thuringiensis israelensis* (Bti) is now available in markets under the trade names Dipel, Thuricide, Biotro and Bactur. The recommended dosage of *B. thuringiensis* is 2.5×10^8 spores per square foot of the target area. It controls potato beetle and elm leaf beetle larvae.

- *Bacillus thuringiensis berliner* has been sold under the trade name Delfin. It is used against pests of cabbage, cauliflower, etc.

- *Bacillus thuringiensis neoleoensis* is used to control pod borer (*Heliothis armigera*).

Bacillus thuringiensis var *karstaki* kills caterpillars.





Fungal Pesticides

Fungi that attack insects and cause disease in them. They are called entomopathogenic fungi. Those fungi which attack pests of crops are now used to control the pests. Such fungi are known as fungal pesticides. Eg. Beauveria

The fungal spores disseminate through wind and reach the target pest. On germination, the spores on the surface of the pest form germ tubes. Each germ tube enters the pest and grows into a mycelium. The mycelium produces fruit bodies on the surface of the pest. On maturation, the fruit bodies disseminate through wind. As a result, the pest dies.

Entomopathogenic fungi are species specific and they even infect sucking insects such as aphids and white flies. They usually cause death of pests by sporulation or toxin secretion. They spread well in humid climates.

i. Beauveria bassiana: The deuteromycetous fungus *Beauveria bassiana* (White muscardine fungus) is pathogenic to a wide group of pests. Conidial suspension of *B.bassiana* (20 gm/100 lit/ha) is sprayed over the crops to control the pests. It is available in the names Mycotrol GH-OF, Boverin and Biocontrol FBB. It has been used to control:

- Coffee berry borer (*Hypothenemus hampei*) damaging immature coffee berries.
- Rice stem borer (*Chilo plejadellus*)
- Colorado beetle (*Leptinotarsa decemlineata*) in potato.
- Mexican bean beetle

ii. Fusarium pallidoroseum: The hyphomycetous fungus *Fusarium pallido-roseum* is pathogenic to many crop pests. The spore suspension is sprayed on crops to control cowpea aphids (*Aphis craccivora* and *Aunguiculata*).

iii. Zoophthora radicans: The zygomycetous fungus *Zoophthora radicans* is pathogenic to some insects and kill them within 7-10 days. The spore suspension of *Z. radicans* is sprayed over rice fields to control larvae of some pests. Eg. *Marasmia patnalis*.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



iv. *Metarhizium anisopliae*: The spore isolate of *Metarhizium anisopliae* is used to control rhinoceros beetles, white grubs, Cutworms and mosquitoes. In the US, it has been Used to destroy household cockroaches.

v. *Nomuraea rileyi*: The spore suspension of *Nomuraea rileyi* has been sprayed over crops to control-

- Larvae of *Spodoptera litura* (in groundnut)
- Gram pod borer (*Helicoverpa armigera*)
- Tobacco budworm (*Heliothis virescens*), etc.

Viral Pesticides

Viruses which selectively kill certain pests of crop plants, are called viral pesticides. They are not harmful to other insects. They are used to destroy the pests of agricultural, horticultural and forest crops.

Granulosis virus, nuclear polyhedrosis virus (NPV) and non-occluded baculovirus or cytoplasmic polyhedrosis virus are being used as viral biopesticides. All the above said viruses belong to Baculovirus group.

1. Granulosis Virus

This is a dsDNA virus that infects codling moth, sugarcane borer, etc. It is isolated from its natural hosts and multiplied in the host in the laboratory. The hosts are then homogenised to get a viral suspension. The viral suspension taken from 800-1000 insects is enough to spray over a hectare. This viral spray suspension kill the pest within 15 days after treatment. Granulosis virus is not pathogenic to honey bees and silk-worms. It kills only selective pests. The cost of viral preparation is very cheap (Rs. 120/ha) In India, sugarcane shoot borer (*Chilo infuscatellus*) is controlled by spraying the suspension of Granulosis virus.

Plodia interpunctella GV is used to control pests of stored grains.

Codling moth on apple, pear, walnut and plum is controlled by treatment with Cyd-X, a formulation of codling moth granulosis virus

2. Nuclear Polyhedrosis Viruses (NPVS)

Nuclear polyhedrosis viruses belong to a sub-group of Baculovirus. They produce poly. hedral bodies in the nucleus of infected cells Suspensions of NPVs have been used to control many crop pests-

i. *Heliothis Nuclear Polyhedrosis Virus*(HNPV): The suspension of HNPV is sprayed onto cotton, maize, sorghum, chickpea and sun-flower to control *Heliothis*. This virus kills the pest within a week. Now it is available in the trade names Biotrol VHZ, Viron/H and Elcartm



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



ii. Lymantria disper NPV: This virus is used to destroy gypsy moth that attack many forest trees. It has been sold in the brand name Gypcheck.

iii. Neodiprion sertifer NPV: This virus is sprayed over pine forests by acroplanet stroy saw flies in pine trees. It is marketed the name Polyviroicide.

3. Non-Occluded Baculoviruses:

They are dsDNA viruses which produce polyhedral polyhedrosis viruses (CPV). They cause dis-eases generally known as cytoplasmic eases in over 200 insect species and destroy them. But they do not affect any organism other than their hosts. So they are employed in pest control. Eg-

i. Rhynchophorus ferrugineus CPV is sprayed onto young coconut palms to destroy pered palm weevils.

ii. Oryctes rhinoceros CPV is used to us) in coconut.

iii. Thaumetopoes pityocamps CPV is used to check the caterpillars of Thaumetopoes pitycampus in pine trees,

4. Genetically Engineered Viruses: P.V. Choudary (1991), isolated toxin encoding gene from scorpion and introduced into a baculovirus. The genetically engineered baculovirus infects pests as usual and produce the scorpion poison inside the pest. It destroys pests more quickly than the parent virus. As it is host specific, there is no harm to other insects and animals.

Bio insecticides

Bioinsecticides are natural substrates derived from natural materials such as animals, plants, microorganisms, and certain minerals. Bioinsecticides are naturally occurring organisms or compounds that inhibit the growth and proliferation of pest populations through a variety of mechanisms of action, including killing on contact, killing after ingestion, repelling, and inhibiting feeding, growth, reproduction, and other mechanisms. Bioinsecticides can be divided into three categories: microbial bioinsecticides, biochemical insecticides, and plant-incorporated protectants (PIPs). Compared to conventional insecticides that bring negative external effects, the bioinsecticides exhibit the advantages of being biodegradable, harmless to non-target organisms, and also have the ability to counteract pest resistance problems caused by synthetic insecticides.

Classification of Bioinsecticides

Biochemical insecticides

Biochemical pesticides are naturally occurring substances from microorganisms, plants or animals that control pests, including pheromones, attractants, repellents, and botanical insecticides. Among them, microbially produced bioinsecticides have been very successfully developed and widely used, such as avermectin and spinosyn, and their chemically modified derivatives, emamectin and spinetoram, respectively, have also been successfully used to produce new insecticides.



Plant-Incorporated-Protectants (PIPs)

PIPs are insecticidal substances produced by plants through exogenous genetic material. For example, Bt toxins are the most common insecticidal proteins expressed in transgenic crops. Genes for Bt proteins are introduced into the plant's own genetic material, and the plant then makes substances that destroy pests.

Microbial bioinsecticides

Microbial bioinsecticides consist of microorganisms (such as bacteria, fungi, viruses) as active ingredients. Microbial insecticides are highly effective, species-specific and eco-friendly bioinsecticides.

Common Microorganisms Used:

- Bacteria: *Bacillus thuringiensis* (Bt), *Bacillus sphaericus*
- Fungi: *Metarhizium anisopliae*, *Beauveria bassiana*
- Viruses: Nuclear Polyhedrosis Virus (NPV)
- Protozoa: *Nosema locustae*

Production of Bioinsecticides

Stages in Bioinsecticide Production

a) Selection of Microbial Strain

- Choose an effective strain that is highly virulent to target insects.
- It should be safe for humans, crops, and beneficial insects.

b) Inoculum Preparation

- A small culture is prepared in lab conditions using nutrient media.
- This "starter culture" is scaled up gradually to prepare for mass production.

c) Mass Cultivation (Fermentation)

- Done in fermenters (bioreactors) using:
 - Nutrient-rich media (e.g., molasses, yeast extract)
 - Aeration, temperature, pH, and agitation are controlled.
- Duration: 2–5 days depending on the organism.

d) Harvesting

- After fermentation, the microbial biomass (spores or cells) is collected.



- This may involve:

- Filtration or centrifugation
- Spray drying (to produce dry powder)
- Freeze drying (for long-term storage)

e) Formulation

- The active microbial ingredient is mixed with carriers like:
 - Talc powder
 - Bentonite clay
 - Lignite
- Stickers or wetting agents may be added.

f) Quality Control

- Tests include:
 - Spore count (CFU/g)
 - Viability
 - Pathogenicity to target insects
 - Absence of contaminants

g) Packaging

- Packaged in moisture-proof, sealed packets or bottles.
- Labeled with strain name, dosage, expiration date, etc.

h) Storage

- Store in cool, dry places (preferably 4–25°C).
- Shelf life: 6–12 months (depending on formulation)

Advantages of Bioinsecticides

Bioinsecticides are safer pest control chemicals that come primarily from natural resources.

Bioinsecticides are usually less toxic than conventional pesticides.

Bioinsecticides are target specific and usually affect only the target pest and closely related organisms, whereas traditional pesticides may affect different organisms such as birds, insects and mammals.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Bioinsecticides are biodegradable, usually effective in very small amounts, and break down rapidly, largely avoiding the environmental pollution caused by traditional insecticides.

Bioinsecticides can significantly reduce the use of traditional insecticides without adversely affecting crop yields.

Examples of Commercial Bioinsecticides

- Bt formulations: Dipel, Thuricide, Bactospeine
- Beauveria bassiana: Mycotal
- NPV for Helicoverpa: Helicide, Heli-NPV

Biofertilizer

A biofertilizer is a substance containing live microorganisms that promote plant growth by increasing the availability of essential nutrients in the soil. These eco-friendly substances use bacteria, fungi, or algae to fix atmospheric nitrogen, solubilize phosphorus and other nutrients, or produce growth-promoting substances, acting as a natural and sustainable alternative to synthetic chemical fertilizers. Biofertilizers enhance soil health, improve crop yields, and are crucial for sustainable agriculture.

Types of Biofertilizers

1. Nitrogen-fixing: Rhizobium, Azotobacter, Azospirillum
2. Phosphate-solubilizing: Bacillus megaterium, Pseudomonas striata
3. Potassium-solubilizing: Frateuria aurantia
4. Mycorrhizal fungi: VAM (Vesicular Arbuscular Mycorrhiza)
5. Cyanobacteria: Anabaena, Nostoc (for paddy fields)

Production of biofertilizers:

1. Selection of Efficient Strain

Purpose: Choosing the right microorganism is crucial for effective nutrient enhancement in the soil.

Criteria for selection:

- High efficiency in nitrogen fixation, phosphate solubilization, etc.
- Adaptability to a wide range of soil and climatic conditions
- Compatibility with target crops (e.g., Rhizobium with legumes)
- Non-pathogenic and environmentally safe



- Fast growth rate and high survival in carrier material

Example strains

- Azotobacter, Azospirillum, Rhizobium, Bacillus megaterium, Frateuria aurantia

2. Inoculum Preparation

Purpose: Develop a pure, active culture to start large-scale production.

Process:

- Microbial culture is grown in sterile nutrient broth (flask or small bioreactor).
- Medium contains suitable carbon and nitrogen sources (e.g., glucose, yeast extract).
- Optimal conditions are maintained:
 - Temperature: ~28–30°C
 - pH: ~6.8–7.2
 - Aeration: Shaking or sparging for aerobic microbes
- Grown for 24–48 hours until high cell density is reached ($\sim 10^8$ – 10^9 CFU/mL)

3. Mass Cultivation

Purpose: Produce microbial biomass on a large scale.

Equipment: Large fermenters (200 to 1000+ liters), sterilized before use.

Process:

- Sterile liquid medium (e.g., molasses, jaggery, yeast extract, minerals) is filled in the fermenter.
- Inoculum is added under aseptic conditions.
- Parameters are monitored:
 - Temperature: maintained for optimum growth
 - Aeration: continuous airflow or mechanical agitation
 - pH: monitored and adjusted if needed
- Duration: 2–5 days depending on microbe type

End result: Fermentation broth containing live, active microbial cells

4. Harvesting

Purpose: Separate and prepare the microbial biomass for formulation.

Steps:



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



- The fermented broth is filtered or centrifuged to concentrate the microbial cells (optional).
- The concentrated cells are mixed with carrier materials (like peat, lignite, or talc powder) in sterile conditions.
- Moisture adjusted to around 35–40% for carrier-based biofertilizers.

Note: For liquid biofertilizers, the broth may be used directly with stabilizers and preservatives.

5. Carrier Preparation

Purpose: Carriers act as a medium to hold and protect microbial cells, allowing easy application to soil or seeds.

Common carriers:

- Peat soil – naturally rich in organic matter
- Lignite – porous, improves moisture retention
- Talc powder – inert, fine-textured, easily mixable
- Press mud – sugar industry waste, organic-rich

Carrier treatment:

- Sterilization (using autoclaving or gamma irradiation) is done to kill any unwanted microbes.
- Drying: Moisture is adjusted to about 35–40% to support microbial survival without promoting contamination or spoilage.

6. Mixing

Process:

- The fermented microbial broth (from step 4) is mixed with the sterile carrier in a sterile mixing unit.
- Mixing ensures uniform distribution of microbial cells throughout the carrier.
- The final formulation should maintain 10^7 to 10^9 CFU/g (colony-forming units per gram) of viable cells.

Conditions:

- Carried out in hygienic, aseptic environments to avoid contamination.
- Optional additives: adhesives or stabilizers to improve shelf life and adherence to seeds.

7. Packaging

Materials Used:



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



- Polythene bags, aluminum-laminated pouches, or HDPE containers
- Sizes: commonly 200g or 500g

Labeling Includes:

- Name of the microbial strain and species
- Type of biofertilizer (e.g., Azotobacter-based)
- Date of manufacture and expiry
- Instructions for usage (seed treatment, soil application, dosage)

Importance: Good packaging ensures protection from moisture, heat, and light, which can kill the microbes.

8. Storage

- Store in a cool, dry place, ideally between 15–25°C.
- Avoid exposure to direct sunlight or high humidity.
- Shelf life ranges from 3 to 6 months depending on the strain and storage conditions.

Quality Standards (BIS - India)

- Viable cell count: Minimum 10^7 CFU/g in carrier-based product
- Contaminants: No harmful or unwanted microbial contaminants
- pH and moisture content within safe limits
- Must pass efficiency tests for nitrogen fixation or phosphate solubilization

Advantages of Biofertilizers

1. Environment-friendly– No pollution or toxic residues
2. Improves soil fertility – Enriches the soil with beneficial microbes
3. Reduces dependency on chemical fertilizers – Cost-effective for farmers
4. Promotes plant growth – Through nutrient availability and hormone production
5. Supports sustainable agriculture – Maintains soil health long term

Single-cell protein (SCP)

Single-cell protein (SCP) is the protein derived from the cells of microorganisms such as yeast, fungus, algae, and bacteria. Protein deficit may be addressed through SCP production in an ever-increasing global population. Agricultural wastes are used to create the microbiological SCP.

The entire organism or dried microbe cells are extracted and consumed.



The SCP is utilized in human food supplements and animal feeds as a protein source.

While the world's population grows, SCP can meet the world's food shortage.

The yeast protein is the only SCP product that can be consumed by humans, whereas the remainder of the SCP can be utilized as animal feed.

The majority of SCPs can be grown on waste items, assisting in the reduction of organic pollution.

Microorganisms Used for SCP

- Bacteria: *Methylophilus methylotrophus*, *Bacillus spp.*
- Yeast: *Saccharomyces cerevisiae*, *Candida utilis*
- Fungi: *Fusarium venenatum* (used in Quorn)
- Algae: *Spirulina*, *Chlorella*

Substrates Used (Raw Materials)

- Molasses, starch, whey, methanol, natural gas, agricultural waste, sewage, etc.

Single-cell Protein Production

1. Selection of Microorganism

- Choose based on:
 - High protein content
 - Fast growth rate
 - Non-toxic and safe for consumption
- Common examples:
 - *Spirulina*, *Chlorella* (algae)
 - *Candida utilis*, *Saccharomyces cerevisiae* (yeast)
 - *Methylophilus methylotrophus* (bacteria)
 - *Fusarium venenatum* (fungus)

2. Substrate Selection

- SCP uses low-cost carbon sources, often industrial/agro-waste:
 - Molasses
 - Starch
 - Methanol, ethanol



-
- Whey (milk industry waste)
 - Food processing waste
 - Agricultural waste

3. Inoculum Preparation

- A small quantity of selected microorganism is grown in nutrient broth.
- Maintained under ideal conditions (sterile, 25–30°C, pH 6.5–7.0).
- This is scaled up gradually before mass fermentation.

4. Mass Cultivation (Fermentation)

- Done in large fermenters under sterile and controlled conditions:
 - Continuous aeration (especially for aerobic microbes)
 - pH control using buffers
 - Temperature control (25–35°C depending on microbe)
 - Substrates are added periodically or continuously.
- Growth duration: 24–72 hours depending on organism.

5. Harvesting of Biomass

- After sufficient growth, the microbial cells are separated using:
 - Centrifugation
 - Filtration
 - Sedimentation
- Biomass is collected as a thick paste or slurry.

6. Cell Processing (Optional)

- Especially for human consumption, certain treatments are done:
 - Cell wall breakdown (to improve digestibility)
 - Reduction of nucleic acids (high levels may cause health issues)
 - Detoxification (if needed)

7. Drying

- The biomass is dried to make it stable and storable:
 - Spray drying (fast and efficient)



- Drum drying
- Freeze drying (for high-quality SCP)
- Result: Protein-rich dry powder

8. Packaging and Storage

- Dried SCP is packed in moisture-proof containers.
- Stored in cool, dry places.

Advantages of Single-Cell Protein

The primary advantage of SCP production is the quantity of protein produced. By providing appropriate conditions, microbial culture can create a high amount of protein.

Microorganisms have a much faster growth rate. Under optimum conditions, these microorganisms can generate a large amount of biomass. Some microbes can double their bulk in 30 minutes.

The quantity and quality of protein generated from these bacteria are superior to that of other animals and plants.

Microbes are easy to manipulate genetically. As a result, diverse amino acid compositions can be observed.

Waste products can be employed as a substrate in the creation of SCPs. This also helps to reduce pollution.

The fermentation procedures, as well as the culture conditions, are both simple.

The generation of microorganisms is not affected by environmental factors.

Disadvantages of Single-Cell Protein

SCP ingestion may be detrimental to humans due to the limited capacity of decomposing nucleic acid. These microorganisms contain 5-15 percent nucleic acid, which can be harmful to humans. It has the potential to induce serious gastrointestinal problems.

SCP can potentially produce allergic reactions in people who have a delicate digestive system or whose bodies fail to recognize the biomass.

A high nucleic acid concentration might also cause an increase in uric acid levels in the blood.



UNIT - IV

Stem Cells production

The undifferentiated animal cells that are capable of proliferation and differentiation to do specialized functions are called stem cells. The stem cells maintain their ability to remain undifferentiated for a long time by means of continuous cell divisions. Under certain physiological (or experimental) conditions, they become differentiated into cells which have special functions. For example, beating cells of heart and insulin-producing cells of pancreas are derivatives of stem cells via differentiation. The cells that regenerate tissues after injury are also example for stem cells.

The stem cell that is capable of continuous proliferation is called actual stem cells. Such cells are found in developing embryos. They produce several types of cells in the organism. The stem cells that become quiescent for some time but able to proliferate again, are called potential stem cells. They are mainly found in adult organs. Here, each stem cell type gives rise to a particular cell type with a specialized function. The stem cells are divided into two types. They are-

1. Embryonic stem cells
2. Adult stem cells

1. Embryonic Stem Cells

Embryonic Stem Cells (ESCs) are a type of pluripotent stem cells that are extracted from the inner cell mass of a blastocyst, an early-stage embryo before implantation. Their capacity to differentiate into any cell type in the body, barring those needed for fetal development, makes them exceptionally valuable in biological research, particularly in regenerative medicine, disease modeling, and drug screening.

2. Adult stem cells

Adult stem cells, also called somatic stem cells, are undifferentiated cells that are found in many different tissues throughout the body of nearly all organisms, including humans. Unlike embryonic stem cells, which can become any cell in the body (called pluripotent), adult stem cells, which have been found in a wide range of tissues including skin, heart, brain, liver, and bone marrow are usually restricted to become any type of cell in the tissue or organ that they reside (called multipotent). These adult stem cells, which exist in the tissue for decades, serve to replace cells that are lost in the tissue as needed, such as the growth of new skin every day in humans.

Embryonic Stem Cell Culture

The rearing of the cells of inner mass of blastocyst in vitro is called embryonic stem cells culture.

It involves the following steps:



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Stem cells are isolated from embryos at blastocyst stage and grown in a suitable chemically defined medium to produce stem cell lines.

Embryonic stem cells are obtained from 3-5 days old embryos called blastocysts. The inner mass of cells in the blastocyst constitutes embryonic stem cells.

To get human blastocysts, the egg is fertilized with sperms by means of invitro fertilization (IVF) technology and grown invitro. The grown-up blastocyst is kept under the micro-scope field and the inner mass of cells (approximately 30) is taken out through a microneedle.

The cells are poured into a plastic tube containing a nutrient broth.

Inner surface of a culture dish is coated with UV irradiated mouse embryonic skin cells which form a feeder layer. The cells of this feeder layer do not divide but they provide a sticky surface for the attachment of ESCs. These cells release certain metabolites necessary for the growth of ESCs in the medium.

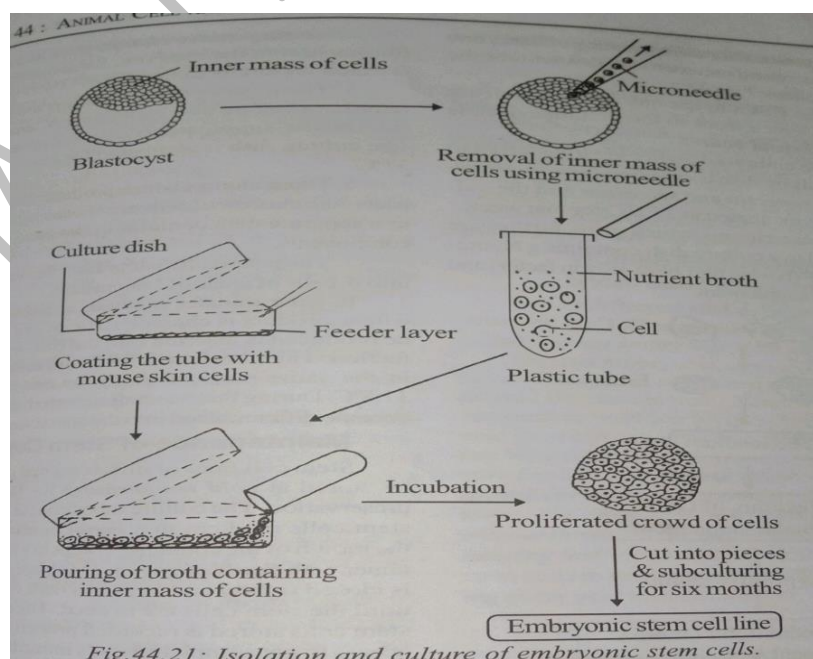
The cells with the nutrient broth are poured into a culture dish and the culture dish is incubated at 37°C for several days. The cells of the inner mass proliferate and form crowds of cells in the culture dish.

The crowd of cells is removed gently and cut into small pieces with a sterile knife.

These pieces are inoculated into fresh culture dishes containing nutrient broth for sub-culturing. Each round of subculture is said to be a passage.

As a result of series of subcultures, millions of embryonic stem cells are obtained

The ESC can proliferate continuous for over six months without differentiation. The embryonic stem cells proliferated for six or more months constitute an embryonic stem cell line (ESCL).





Stem cell bank

A stem cell bank is a facility that collects, processes, and stores stem cells (from sources like umbilical cord blood, bone marrow, fat tissue) for potential future medical use, offering "biological insurance" for treating diseases like cancers, blood disorders, and autoimmune conditions. Banks can be private (for family use) or public (for donation), with private storage preserving cells for the donor or relatives, while public banks serve anyone needing them. The cells are preserved at extremely cold temperatures (like -196°C in liquid nitrogen) for long-term viability.

By banking these diverse stem cell sources, families create a comprehensive and readily available resource with the potential to treat over 80 conditions. This service provides security for the family, and is a vital tool for the advancement of stem cell therapy, expanding the potential applications beyond what cord blood or tissue banking alone can provide.

Types of Stem Cell Banking

Cord Blood Banking: Most common, collecting blood from the umbilical cord and placenta after birth.

Adult Stem Cell Banking: Harvesting from bone marrow, peripheral blood, or fat tissue.

Amniotic Stem Cell Banking: Storing stem cells from amniotic fluid.

Embryonic Stem Cell Banking: Storing cells from embryos (less common for personal use).

Types Of Stem Cell Banks

There are two types of banks where you can preserve your newborn's cord blood stem cells. They are:

Public Banks - This banking model works on a donation basis where parents can donate their baby's stem cells for free. The donated cord blood units are added to a common pool which is then made accessible to the general public. In times of medical necessity, anyone can purchase a matching cord blood unit for a reasonable amount from the public bank. However, once donated, the baby's parents do not have any claim or access to the donated stem cells.

Private Banks - It's a private entity where parents pay an annual amount to preserve their baby's stem cells for private use. The preserved stem cells can be used by their family members in times of medical emergencies. Each bank charges a distinct processing and storage fee. However, the Indian Academy of Pediatrics (IAP) advises Indian families to bank their child's cord blood stem cells in public banks in comparison to private ones. This is because the possibility of the baby using its own stem cells is less than 0.04%.



Steps

1. Enrollment & Consent

- Parents register with a private or public stem cell bank during pregnancy.
- A consent form is signed, allowing collection and storage of cord blood after delivery.

2. Collection of Cord Blood

- After the baby is born and the umbilical cord is cut, the leftover cord blood (which is rich in stem cells) is collected.
- A sterile needle and collection bag are used to draw the blood from the cord.
- The process is painless, safe, and takes about 5–10 minutes.

3. Transportation

- The cord blood unit is packed in a temperature-controlled container and sent to the processing lab, usually within 24–48 hours.

4. Processing

- In the laboratory, cord blood is processed to separate stem cells from plasma and red blood cells.
- The most commonly used method is density gradient centrifugation or automated separation.

5. Testing

- The stem cell sample is tested for:
 - Cell count (especially CD34+ stem cells)
 - Viability (how many cells are alive and usable)
 - Infectious diseases (e.g., HIV, Hepatitis B/C)
 - Contamination (bacteria or fungi)

6. Cryopreservation

- The processed stem cells are mixed with cryoprotectants (like DMSO) to prevent ice damage.
- Then they are slowly frozen and stored in liquid nitrogen tanks at -196°C .

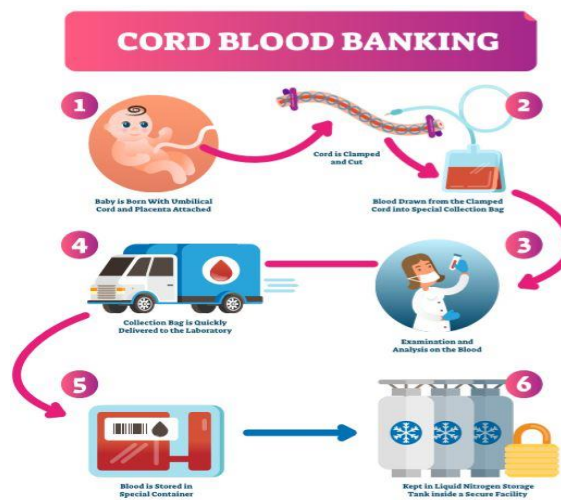
7. Long-Term Storage

- Stem cells are stored securely in barcoded containers.
- They can be stored for 15–25 years or more.
- When needed, the sample is thawed and used for transplantation or treatment.



These stem cells can treat diseases like:

- Blood cancers (leukemia)
- Immune disorders
- Thalassemia
- Some metabolic diseases



MONOCLONAL ANTIBODY

Monoclonal antibodies (mAb) are antibodies that are identical because they are produced by one type of immune cell, all clones of a single parent cell. Basically, produced by white blood cell which is called a plasma cell. Is used for treatment of cancerous cells and as anti-venom (anti snake venom)

The principle of monoclonal antibody (mAb) production centers on creating identical antibodies from a single B-cell clone, primarily using Hybridoma Technology: an animal is immunized with an antigen, its antibody-producing B-cells are fused with immortal myeloma (cancer) cells, creating "hybridomas" that multiply indefinitely and secrete specific antibodies, which are then selected and mass-produced for therapeutic/diagnostic use.

PROCEDURE:

1. Immunization of specific animals which generate hybridoma cells with spleen cells.
2. Isolation of myeloma cells.
3. Fusion between spleen cell and myeloma cell.
4. Selection of HAT medium.
5. Isolation of hybridoma cells.
6. Screening of hybridoma cells.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



1. Immunization of specific animals: An antigen immunized to an animal (like mice) via intravenously (directly to blood) by injection. Where in the spleen it activates the B-cell which produces plasma cells (spleen cells). Plasma cell to produce monoclonal antibodies Isolation of plasma cell from spleen of animal

2. Isolation of myeloma cells: Myeloma cells are cancerous cells which are isolated from bone-marrow. Myeloma cells are generally immortal in nature (that which never dies) and have multiplication properties.

3. Fusion of spleen cell and myeloma cell: It requires a PEG (polyethylene glycol) medium for fusion. It can also be done by electro fusion. Fusion between spleen cell and myeloma cell produced five different types of cells. Fused plasma Fused myeloma Hybridoma Unfused plasma Unfused myeloma

4. Selection of HAT medium: (Hypoxanthine, Aminopterin, Thymidine) Before multiplication of Antibody, it has to synthesize a new copy of DNA and for that it requires synthesis of nucleotides. For synthesis of nucleotides mainly two pathways are there: 1. Salvage pathway 2. De-novo Synthesis. In 1, Salvage pathway requires degraded part of old nucleotide to produce new nucleotide. In 2, De-novo synthesizes completely new nucleotides by small molecules (sugar, amino-acid).

So, in HAT medium, Cells are not synthesized by De-novo synthesis due to presence of Aminopterin in HAT medium which blocks Do-hydro folate enzyme which is necessary for this synthesis. For synthesis in the salvage pathway, it must require the HGPRT enzyme (Hypoxanthine Guanine Phospho-Ribosyl Transferase). Where hypoxanthine and thymidine are used as precursors.

5. Isolation of hybridoma cells: Myeloma cell doesn't have HGPRT enzyme Spleen cells have HGPRT enzyme 1. Fused plasma present 2. Fused myeloma absent 3. Hybridoma present 4. Unfused plasma present 5. Unfused myeloma absent HGPRT

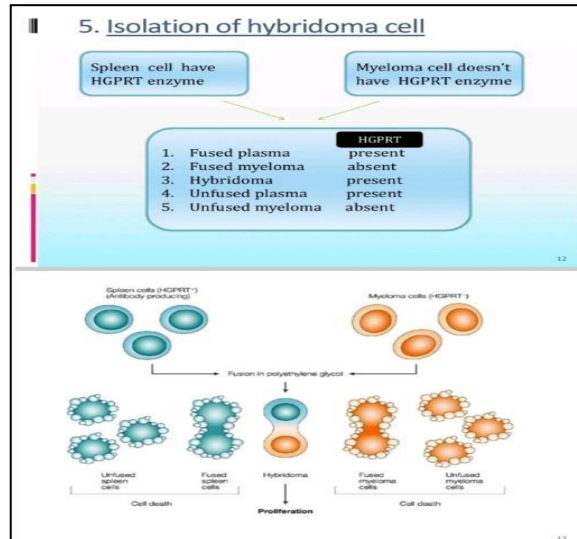
Fused myeloma and unfused myeloma didn't have HGPRT enzyme so, can't survive in HAT medium. Fused plasma and unfused plasma have HGPRT enzymes but don't have long-life. Hybrid cells have HGPRT enzymes from the spleen cell as well as they have the ability to multiply repeatedly as myeloma cells. So, isolation of hybrid cells is the only cell which survives in HAT medium.

6. Screening of hybridoma cells: ELISA screening method which is done by incubating hybridoma culture in which secondary enzymes get conjugated and formation of colored products shows positive hybridoma. Used for multiplying the hybridoma cells In-vivo or In-vitro

In-vivo procedure involves introduction of hybridoma cells into the peritoneal cavity of the animal, then from ascitic fluid antibodies are isolated. In-vitro method involves culturing of hybridoma cells in suitable culture media and then antibodies are isolated and purified. Once a hybridoma



colony is established, it will continually grow in culture mediums like RPMI-1640 and produce antibodies. Storage: liquid nitrogen.



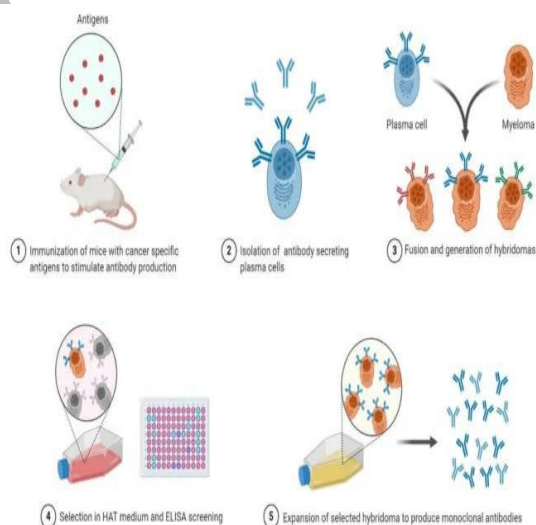
Functions and Applications of Monoclonal Antibodies

Monoclonal antibodies are used in the treatment of several diseases and disorders and their application is known as immunotherapy.

Some diseases and disorders treated using mAbs include: Cancers, Rheumatoid arthritis, Multiple sclerosis, Systemic Lupus erythematosus, Cardiovascular diseases, Crohn's disease, Ulcerative colitis, Psoriasis, and Rejections associated with transplantation

Monoclonal antibodies are widely used in therapies, laboratory technique studies, and research for potential treatments for certain infections, disorders, and cancers

Commonly, monoclonal antibodies were initially studied in cancer treatment where they are currently used in the treatment of some types of cancer.





Polyclonal Antibody Production

Polyclonal antibodies are produced by immunizing an animal, such as a rabbit, with a specific antigen. The animal's immune system responds by activating multiple B-cell clones, each producing antibodies against different epitopes (specific sites) on the antigen. After multiple immunizations over several weeks, blood is collected, and the serum is processed to isolate a mixture of these different antibodies.

1. Antigen preparation

The first step in polyclonal antibody production is antigen preparation. The target antigen can be a purified protein, a peptide, or a mixture of proteins, depending on the application. The purity and quality of the antigen are critical to the success of the antibody production process.

2. Immunization

Immunization is the second step in polyclonal antibody production, where animals are injected with the antigen of interest. The antigen is typically mixed with an adjuvant such as Freund's adjuvant to enhance the immune response. The adjuvant helps to stimulate the animal's immune system, resulting in a stronger antibody response. Multiple immunizations, known as boosters, are typically administered over a period of 4 to 8 weeks to maximize antibody production.

3. Serum Collection

After immunization, the animal's blood is collected to obtain serum containing the polyclonal antibodies. The serum is then subjected to an initial screening test to determine the titer of the antibodies. The antibody titer is a measure of the concentration of antibodies in the serum and reflects the strength of the antibody response.

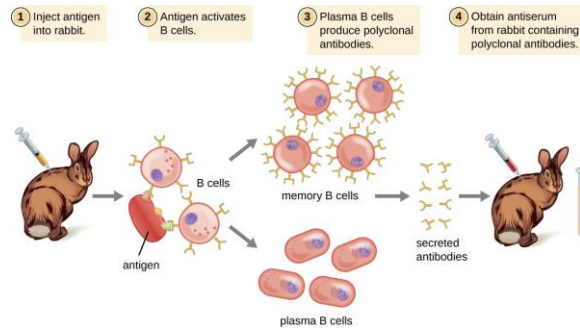
4. Purification

The next step is antibody purification, which involves isolating the specific antibodies of interest from the serum. This can be done using a variety of methods such as protein A or protein G affinity purification.

Affinity purification involves using a column containing the antigen or a related molecule to selectively bind the antibodies with the highest affinity. This results in a highly enriched population of polyclonal antibodies that can be used in various applications.

5. Characterization

The final step in polyclonal antibody production is the characterization of the purified antibodies. This involves determining the specificity and sensitivity of the antibodies to the antigen of interest. Immunoglobulin G (IgG) is the most commonly used class of antibodies in research and diagnostics due to their high affinity and specificity.



Second metabolite production

Secondary metabolites are organic compounds produced by plants, fungi, bacteria, and animals that are not directly involved in growth, development, or reproduction

Often used for defense, pigmentation, scent, or signaling.

Found mostly in plants and microorganisms.

Production of Antibiotics

Antibiotics are substances, produced by one micro-organism that inhibits the growth of or kills another micro-organism. Antibiotics are mainly produced by Streptomyces, Nocardia, Bacteria and Fungi. Antibiotics are the most widely used chemotherapeutic agents. At present more than 5000 antibiotic chemicals are known. Of these 100 antibiotics are available for medical use.

The following are the most-used groups of antibiotics:

- 1. Penicillins:** Penicillins are produced by *Penicillium* species of fungi. They are harmful to Gram positive bacteria. They inhibit cell wall synthesis of bacteria.
- 2. Streptomycins:** Streptomycins are produced by the bacterium *Streptomyces griseus*. They are harmful to Gram positive and Gram-negative bacteria. It inhibits protein synthesis.
- 3. Tetracycline:** It is produced by the bacterium *Streptomyces aureofaciens*. It is a broad-spectrum antibiotic. It inhibits protein synthesis.
- 4. Erythromycin:** It is produced by the bacterium *Streptomyces erythreus*. It kills Gram positive bacteria. It inhibits protein synthesis.
- 5. Chloramphenicol:** It is produced by *Streptomyces venezuelae*. It is a broad-spectrum antibiotic. It prevents protein synthesis.

Penicillins

Penicillins are a group of antibacterial antibiotics produced by the fungus *Penicillium* sp.

Penicillin is produced by the fungi *Penicillium notatum* and *P. chrysogenum*. The penicillin producing bacterium was first identified by Alexander Fleming in 1928. The penicillin was discovered, named and described by Alexander in 1929.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Penicillin has a bactericidal action. It inhibits the synthesis of the cell wall of the bacteria. It is an effective agent against *Staphylococci*, *Streptococci*, *Pneumococci*, *Meningococci* and a few other bacteria.

It is an effective medicine for the treatment of syphilis.

Penicillin exists in many forms such as Penicillin G, Penicillin V, Ampicillin, etc.

Penicillin G is obtained from the cultures of *Penicillium* sp. Penicillin V obtained from the culture when it is added with phenoxy acetic acid.

Ampicillin is a semisynthetic penicillin.

The nucleus of all types of penicillin's has the same structure. But the side chain R differs.

Penicillin is an organic acid.

Penicillin is useful in the treatment of bacterial endocarditis, mastoiditis, gonorrhoea, local infections and certain types of pneumonia.

Production of Penicillin

Penicillin is commercially produced in the industry by culturing the fungus *Penicillium chrysogenum* or *Penicillium notatum*.

The fungus can be cultured in two methods, namely surface culture method and submerged culture method.

- Surface culture method: the fungus is cultured on the surface of a liquid medium without agitation. After an appropriate incubation period, the penicillin is extracted from the medium. This is an old method.

- Submerged culture method: the fungus is grown in a liquid medium which is vigorously aerated and agitated. After appropriate incubation, the penicillin is separated from the medium. Today penicillin is produced by the submerged method.

Penicillin production

Penicillin is produced either by batch culture or continuous culture method. Penicillin production needs an aseptic condition. It needs a tremendous amount of air. The production of penicillin involves a chemical process called antibiotic fermentation. The industry is called antibiotic fermentation industry.

The fermentation unit consists of the following main components:

1. Fermenter (culture vessel)
2. Mixing tank
3. Seed tank



4. Recovery tank

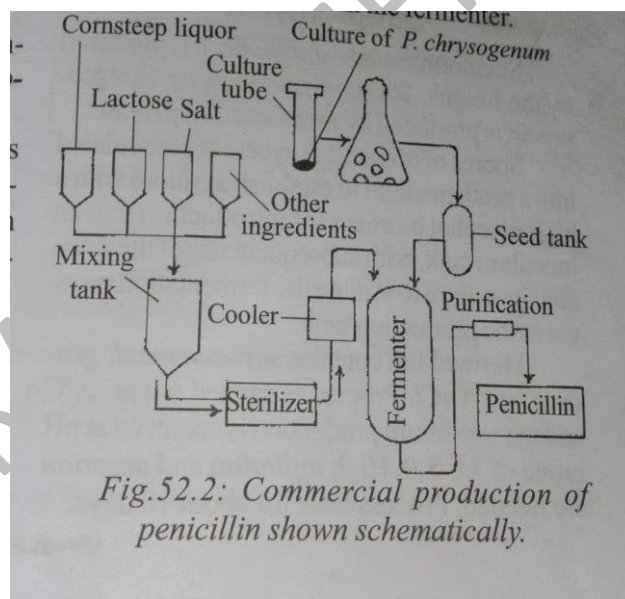
The fermenter is the culture vessel. It receives the medium from a mixing tank and the fungus *Penicillium chrysogenum* from a seed tank.

- The seed tank receives the fungus from a culture tube.
- The mixing tank receives the raw materials for the medium.

Raw materials of the medium include:

- Corn steep liquor (a by-product of maize)
- Lactose
- Glucose
- Salts
- Phenylacetic acid
- Calcium carbonate (as buffer).

The medium and the fungus are well mixed by an agitator provided in the fermenter.



Medium → Fermenter (Fungus) → Centrifugation → Filtration → Solvent Extraction → Precipitation → Crystallization

The fermenter is supplied with filtered sterilized air.

The fungus grows as pellets. In seven days, the fermentation process is completed and penicillin is produced in the medium.

The mass of fungus is separated from the culture medium by centrifugation and filtration.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Penicillin is then extracted from the clear fluid by solvent extraction process using amyl acetate or butyl acetate.

Finally it is purified by precipitation and crystallization.

Probiotics

Probiotics are specific living microorganisms, most often bacteria or yeast that help the body digest food or help with symptoms of certain illnesses. Probiotics are naturally found in fermented foods such as yogurt and sauerkraut.

When you lose "good" bacteria in your body, for example after you take antibiotics, probiotics can help replace them.

They can help balance your "good" and "bad" bacteria to keep your body working the way it should.

Lactobacillus. This may be the most common probiotic. It's the one you'll find in yogurt and other fermented foods. Different strains can help with diarrhea and may help people who can't digest lactose, the sugar in milk.

Bifidobacterium. You can find it in some dairy products. It may help ease the symptoms of irritable bowel syndrome (IBS) and some other conditions.

Saccharomyces boulardii is a yeast found in probiotics. It appears to help fight diarrhea and other digestive problems. Here's what to look for when choosing the best probiotic for women and men.

Curd

- Curd is a dairy product.
- It is obtained by coagulating milk in a process called curdling.
- It is a fermentation product of milk.

Ingredients

1. Milk
2. Lactobacillus bacteria

Preparation

- Milk is boiled to 72°C.
- It is called pasteurization.
- The boiled milk is called pasteurized milk.
- It is cooled to room temperature.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



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- Lactobacillus or a small amount of old curd (starter culture) is added.
 - It is allowed to sit in room temperature.
 - The bacteria start to grow.
 - They convert the lactose of milk into lactic acid.
 - The lactic acid imparts the sour taste to curd.

Yogurt (Yoghurt)

- Yogurt is a dairy product.
- It is obtained by coagulating milk in a process called curdling.
- It is a fermentation product of milk.

Ingredients

1. Milk
2. Lactobacillus delbrueckii subsp. bulgaricus and Streptococcus thermophilus (bacteria)

Preparation

Milk is heated to about 85°C.

Denature the milk proteins to avoid curd formation.

The milk is allowed to cool about 45°C

The milk is inoculated with starter culture containing the following bacteria:

1. Lactobacillus bulgaricus
2. Streptococcus thermophilus

The mixture is stirred well.

It is allowed to sit for 5-12 hrs.

The temperature is maintained to 45°C.

Cheese

Cheese is a dairy product.

It is formed by coagulation of milk protein casein.

Ingredients

- Milk
- Salt



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



- Starter culture containing

- *Lactococcus* or

- *Lactobacillus* or

- *Streptococcus families*

- Vinegar

- Renin (enzyme)

Preparation

Cheese making involves 3 steps namely

1. Curdling

2. Curd processing

3. Ripening

1. The milk is not boiled for cheese making.

2. The milk is acidified by adding vinegar or starter culture of bacteria.

3. The starter culture include the following bacteria

- *Lactococcus* or

- *Lactobacillus* or

- *Streptococcus families*.

4. The bacteria convert milk sugars into lactic acid.

5. The enzyme rennet is added.

6. Vinegar or lactic acid produced by the bacteria curdles the milk.

7. Rennet sets the cheese in a strong and rubbery gel from the fragile curd.

8. The soft cheese is drained, salted and packaged.

9. Salt adds salty flavour to cheese, in addition it preserves cheese from spoiling, draws moisture from the curd and gives a firm texture to the cheese.

10. Cheese is left to rest under controlled condition. This is called ripening or aging.

11. The ripening period lasts from a few days to several years.

12. Ripening adds texture and flavor.



Prebiotics

Prebiotics function as a food source for your gut's microorganisms and they need to bypass digestion and make it all the way to your colon. There, the microorganisms metabolize and ferment the prebiotics to survive. This metabolism and fermentation process is beneficial to your gut health because it creates a variety of other by-products that help you in a number of ways.

When prebiotics are broken down by the microorganisms in your gut, different short-chain fatty acids are created depending on the kind of prebiotic. As a result, these short-chain fatty acids do a number of things like provide energy to your colon cells, help with mucus production and aid in inflammation and immunity.

“Different microorganisms may use different prebiotics, so not every prebiotic gives you the same effect.

Prebiotic foods are usually high in certain types of fiber known as fermentable soluble fiber. How you cook your food determines how many prebiotics are available, too, because your food changes composition based on how you cook it (or not cook it). Although there are many kinds of prebiotics, three of the most common are found in resistant starches, inulin and pectin.

Resistant starches

Like fiber, resistant starches resist digestion and end up as a main food source for microorganisms in your colon. When resistant starches are broken down, they often produce butyrate, which helps with water and electrolyte absorption, immune system functionality and anti-inflammation.

Boiled and chilled potatoes, Green bananas, Barley, Oats, Rice, Beans, Legumes.

Inulin

Inulin is a prebiotic fiber contained in many plants. This prebiotic can help you feel full for longer periods, assisting with overeating and helping with bowel movements. It can also help lower LDL cholesterol (bad cholesterol), stabilize blood sugars and increase and maintain the good bacteria in your gut. It may also help reduce your risk of colon cancer.

Asparagus, Burdock root, Chicory root, Dandelion greens, Garlic, Jerusalem artichokes, Leeks, Onions, Soybeans, Wild yams.

Pectin

Pectin in a lot of fruits, especially in the pulp of raw apples. Pectin is a type of gel-like starch, often used to create jams and jelly. This starch has antioxidant and anti-tumor properties. It also may enhance the skin cells of your intestinal lining.

Apples, Apricots, Carrots, Green beans, Peaches, Raspberries, Tomatoes, Potatoes.

Benefits

Help regulate bowel movements.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Produce neurotransmitters that go back and forth between your gut and your brain to trigger mood changes and other processes.

Stimulate your body to make hormones that aid in appetite, appetite suppression and more.

Help your bones mineralize and absorb calcium and phosphorus, which can improve bone density.

Improve how well your immune system functions.

Enhance your body's anti-inflammatory response.

Increase production of good bacteria and decrease bad bacteria that causes disease.

KAMARAJ WOMENS COLLEGE



UNIT - V

Project Management

What Is a Project?

A project can be simply defined as an endeavor that involves completing tasks to achieve an objective with a limited set of resources and a finite timeline.

Project Management

Project management is a process that allows project managers to plan, execute, track and complete projects with the help of a project team. To do so, they must use project management principles, skills, methodologies and tools to lead team members through each of the project management steps which are known as the project lifecycle.

Project management is made up of five key components: initiation, planning, execution, monitoring and controlling, and project closure.

1. Project Initiation

This is the starting phase where the project manager must prove that the project has value and is feasible through a series of project management documents.

Business case: A business case justifies the need for the project, project objectives and return on investment.

Feasibility study: A feasibility study proves that the project can be executed within a reasonable time and cost.

Project charter: A project charter conveys what the project is going to deliver.

Once the project gets approved, the project manager must assemble a project team and set up a project management office. The project initiation phase ends with a kickoff meeting, which is when project goals and scope are defined.

2. Project Planning

The goal of the project planning phase is the creation of the project plan, a comprehensive project document that explains in great detail how the project will be executed.

Project schedule: The project schedule defines a timeline for the execution of tasks and resource allocation.

Project budget: A project budget is the sum of all the estimated project costs.

Scope management plan: Explains how your project scope will be tracked throughout the project.

Risk management plan: Explains the risks that might affect the project, along with strategies to mitigate them.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Resource management plan: Describes how your resources will be obtained, allocated and managed during the project.

Stakeholder management plan: Identifies all project stakeholders and the guidelines to manage them.

Project managers often lay out their project plan using Gantt chart software, which provides a visual representation of the entire project schedule and project scope. Some Gantt charts automatically identify critical path activities.

3. Project Execution

The third project management phase is project execution, which is when the project plan is executed to meet the project goals and objectives.

The project execution phase is when project managers need to oversee the project management knowledge areas as their project progresses toward the monitoring and control phase.

Along the way, the project manager make changes to the project execution plan such as reallocating resources or adjusting the time and scope as needed to keep the team working. In addition, they'll identify and mitigate risks, deal with problems and incorporate any changes.

4. Project Monitoring and Control

The fourth project management phase, project monitoring and control, takes place concurrently with the execution phase of the project. It involves monitoring the progress of the project execution activities to ensure the project team stays on schedule and within budget. Quality control procedures are applied to guarantee quality assurance.

Reporting is also a critical part of this project management phase. First, it allows project managers to track progress, and second, it provides data for stakeholders during presentations to keep them in the loop. There are many project management reports such as project status, timesheets, workload, allocation and expense reports.

5. Project Closure

The fifth project management phase is project closure, in which the final project deliverables are presented to the stakeholders. Once approved, resources are released, documentation is completed and everything is signed off on.

Benefits of Project Management

Improved planning and organization

Enhanced communication

Increased efficiency

Higher quality deliverables



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Better time management

Cost control

Technology management

Technology management refers to the planning, organization, and control of an organization's technology resources, including hardware, software, and networks, to achieve its strategic goals and objectives.

It goes beyond mere maintenance; it focuses on optimizing systems to enhance productivity and efficiency, ultimately empowering people to work better.

At its core, technology management is about aligning people and technology to fulfill expectations efficiently.

Components of Technology Management

Technology Strategy:

This component involves developing a clear and comprehensive strategy for how technology will support the organization's business objectives. It includes defining the organization's technology goals, roadmap, and resource allocation.

Technology Roadmap:

A technology roadmap outlines how the organization plans to adopt and implement new technologies over a specified period. It outlines how new technologies will be implemented over a specified period, aiding in prioritizing technology initiatives, allocating resources, and aligning with strategic goals.

Technology Forecasting:

Technology forecasting is the process of predicting future technology trends and developments. It entails analyzing data, identifying patterns, and forecasting technology in a specific industry or field. This information guides decision-making and strategic planning, helping organizations remain at the forefront of technological innovation.

Technology Governance:

Technology governance refers to the policies, procedures, and decision-making processes that ensure technology is managed in alignment with the organization's goals and complies with relevant regulations and standards. It provides a framework for effective technology management.

Vendor Management:

Vendor management involves overseeing relationships with third-party technology providers. It includes identifying potential vendors, negotiating contracts, monitoring performance, and



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



ensuring compliance with standards and policies. Effective vendor management ensures technology solutions meet an enterprise's needs, are delivered on time, within budget, and receive ongoing support.

Infrastructure Management:

This component involves managing the underlying hardware and software infrastructure that supports an organization's technology services. It includes planning, designing, implementing, and maintaining servers, storage, network devices, and other components.

Application Management:

Application management involves overseeing software applications used within an organization. This includes installation, maintenance, troubleshooting, upgrades, and ongoing support, all aimed at improving productivity, reducing costs, and increasing the value of technology investments.

Security Management:

Security management focuses on protecting an organization's technology assets, including hardware, software, and data, from potential threats, data breaches, and vulnerabilities. It involves designing, implementing, and maintaining security measures such as firewalls, access controls, and encryption.

Cybersecurity Management:

This component focuses specifically on protecting digital assets from cyber threats such as data breaches, malware, and hacking. It includes risk assessment, threat mitigation, and incident response planning.

Data Management:

Effective data management involves establishing processes, policies, and procedures for creating, storing, protecting, and making data available to users. It ensures data quality, consistency, privacy, and security.

IT Budget Management:

The IT manager is also responsible for managing the budget allocated to information technology. This involves allocating resources, monitoring expenditures, and ensuring technology investments align with the organization's objectives.

Start up schemes

1. Start up India Initiative

Launched in 2016, the Start up India Initiative is a flagship program aimed at fostering entrepreneurship and innovation. Designed to create a start up-friendly ecosystem, the initiative offers:



ACADEMIC YEAR 2025-2026, SEMESTER – VI STUDY MATERIAL FOR B.Sc. MICROBIOLOGY BIO ENTREPRENEURSHIP AND BIOBUSINESS



Tax Exemptions u/s 80 IAC.

Simplified regulations with relaxed labor laws and fast-tracked patent processing.

Access to funding up to ₹50 lakhs via the ₹1,000 Crore Start up Seed Fund introduced in 2021.

Register here to enjoy these benefits.

Moreover, the initiative includes the Start up India Hub, a networking platform connecting start ups with investors and mentors, and the Atal Innovation Mission, which encourages innovation at grassroots levels. With these offerings, Start up India empowers entrepreneurs to scale their businesses and drive economic growth.

2. Pradhan Mantri Mudra Yojana (PMMY)

Since its launch in 2015, the Pradhan Mantri Mudra Yojana (PMMY) has provided financial assistance to micro and small enterprises (MSEs). It offers collateral-free loans up to ₹10 Lakhs under 3 categories:

Shishu: For early-stage start ups.

Kishor: For scaling businesses.

Tarun: For established businesses needing larger capital.

The scheme helps entrepreneurs acquire equipment, raw materials, and working capital. Accessible through banks, microfinance institutions, and NBFCs, PMMY has fueled countless success stories, created jobs and boosted India's entrepreneurial ecosystem.

3. Stand-Up India

Launched in 2016, Stand-Up India promotes entrepreneurship among women and disadvantaged communities (SC/ST) by offering loans of up to ₹1 Crore. Designed for greenfield enterprises in manufacturing, trading, or services, the scheme also provides:

Handholding support, including mentorship and training.

Market linkages to connect entrepreneurs with potential buyers and investors.

By addressing financial and structural barriers, Stand-Up India empowers under-represented groups (women, disadvantaged sections of society, etc.,) to contribute meaningfully to India's economic growth. With these offerings, Stand-Up India has provided funding to 1000s of entrepreneurs across the country, thereby creating job opportunities and contributing to economic growth.

4. Biotechnology Ignition Grant

Administered by the Department of Biotechnology, the Biotechnology Ignition Grant (BIG) supports early-stage biotech start ups. It provides funding of up to ₹50 Lakhs for:



Proof-of-concept studies.

Technology validation.

This program has catalyzed breakthroughs in healthcare, agriculture, and environmental conservation, solidifying India's position in the global biotech arena.

5. Credit Guarantee Fund Scheme for Start ups (CGSS)

The Credit Guarantee Fund Scheme for Start ups (CGSS) offers collateral-free loans of up to ₹2 Crores, ensuring access to credit for early-stage ventures. Implemented through a network of financial institutions, the scheme covers:

Working capital.

Term loans.

Other credit requirements.

With the added benefit of mentorship and training, CGSS provides start ups with the support they need to scale their operations.

Building a Biotech Business: Challenges in Indian Context and the biotech partners involved

I. Challenges in Building a Biotech Business in India

1. High R&D Cost and Long Development Time

- Biotech products (like vaccines, biofertilizers, drugs) require intensive research, long testing, and validation.
- R&D cycle can take 5–10 years or more, with high financial risk and delayed returns.
- Challenge: Limited access to venture capital or private investment.

2. Regulatory Complexity

- Biotech products must pass approvals from multiple government bodies:
 - DBT – Department of Biotechnology
 - ICMR – Indian Council of Medical Research
 - CDSCO – Drug Controller for clinical trials/therapeutics
 - FSSAI – For food-related biotech products
- Challenge: Regulatory process is lengthy, confusing, and lacks coordination.

3. Weak Intellectual Property (IP) Support

- Many biotech start ups hesitate to invest in innovation due to:



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



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- Complex patenting processes
 - High cost of filing and maintaining international patents
 - Lack of IP literacy

4. Poor Industry-Academia Collaboration

- Indian research institutions often work in isolation from industries.
- Challenge: Innovations don't reach market due to lack of translation and commercialization support.

5. Limited Infrastructure & Incubation Support

- Very few biotech parks or incubators with lab access, especially in Tier-2/3 cities.
- Start ups lack:
 - Pilot-scale production facilities
 - Testing labs
 - Cold storage/logistics systems

6. Public Resistance & Awareness

- Misconceptions about GMOs, vaccines, and synthetic biology.
- Challenge: Lack of science communication and public education reduces acceptance.

7. Market Access & Scalability Issues

- Difficulty in:
 - Scaling lab-level innovations to industrial production
 - Getting certifications (like WHO-GMP, NABL)
 - Competing with imported biotech products due to pricing or quality perceptions

II. Biotech Partners in India (Supporting Ecosystem)

1. Government Agencies

- DBT (Department of Biotechnology):
 - Policy, research funding, and national biotech mission
- BIRAC (Biotechnology Industry Research Assistance Council):
 - Provides funding, incubation, mentoring, IP support
 - Popular schemes: BIG Grant, PACE, BioNEST



2. Research & Academic Institutions

- Collaborate for R&D, manpower training, and testing
- Examples:
 - IITs, IISc Bengaluru, NIPERs, AIIMS, University of Hyderabad
 - Help in clinical trials, molecular biology, drug screening

3. Biotech Incubators & Bio-clusters

- Offer infrastructure, mentorship, and networking
 - C-CAMP (Bengaluru)
 - IKP (Hyderabad)
 - BioNest, TBI (Technology Business Incubators)

4. Private Industry & Big Biotech Companies

- Can partner for manufacturing, testing, or investment
- Examples:
 - Biocon (biopharma)
 - Serum Institute (vaccines)
 - Panacea Biotec
 - Bharat Biotech

5. Angel Investors & Venture Capital

- Early-stage funding for biotech start ups
- Examples:
 - India Angel Network, Bharat Innovation Fund, Venture Center Pune

Conclusion:

To build a successful biotech business in India, strong collaboration is needed between:

- Government
- Academia
- Industry
- Start ups

Also essential: policy support, IP protection, funding, and public trust.



ACADEMIC YEAR 2025-2026, SEMESTER – VI STUDY MATERIAL FOR B.Sc. MICROBIOLOGY BIO ENTREPRENEURSHIP AND BIOBUSINESS



BIRAC

The Biotechnology Industry Research Assistance Council, established by the Department of Biotechnology (DBT), Government of India, is a dynamic force driving innovation, research, and entrepreneurship in the biotechnology sector. BIRAC acts as a catalyst for fostering strategic partnerships between academia, industry, and other stakeholders, revolutionizing the biotechnology landscape in India.

Vision

BIRAC envisions creating a robust ecosystem that nurtures innovative research, accelerates biotechnology entrepreneurship, and paves the way for a sustainable biotech industry. This vision aligns with India's aspirations to become a global biotech hub.

Key Strategies

BIRAC employs strategic approaches to achieve its mission:

Promoting Innovation: BIRAC fosters innovation by providing grants, mentoring, and support to biotech start ups and entrepreneurs.

Facilitating Research-Industry Interface: BIRAC bridges the gap between research institutions and industry by catalyzing collaborative projects.

Enhancing Skill Development: BIRAC invests in capacity-building initiatives to cultivate a skilled workforce for the biotech sector.

Encouraging Entrepreneurship: BIRAC empowers biotech start ups with funding, infrastructure, and guidance to translate ideas into marketable products.

BIRAC's Programs

BIRAC's portfolio comprises various programs, each aimed at addressing specific facets of biotechnology innovation and entrepreneurship.

Incubation

BIRAC supports biotech start ups by providing financial assistance, incubation facilities, and mentorship.

Incubators under BIRAC's umbrella offer a nurturing environment for start ups to develop and refine their ideas.

Biotechnology Industry Partnership Programme (BIPP)

BIPP encourages collaboration between industry and academia by providing grants for innovative research projects.

It accelerates the translation of research findings into tangible products with commercial viability.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Small Business Innovation Research Initiative (SBIRI)

SBIRI fosters innovation within small and medium-sized enterprises (SMEs) by providing funding for high-risk, high-reward projects.

It aims to transform SMEs into key players in the biotech industry.

Translation Research

BIRAC funds translational research projects that aim to bridge the gap between laboratory discoveries and real-world applications.

This initiative catalyzes the transformation of research findings into practical solutions.

Social Innovation

BIRAC recognizes the power of biotechnology to address societal challenges and supports innovative solutions to pressing issues.

Social innovation projects focus on healthcare, agriculture, environment, and more.

Equity Funding

BIRAC provides equity funding to start ups with innovative technologies that have the potential to disrupt markets.

This funding mechanism aids start ups in scaling up and entering the commercial market.

Product Commercialization Program (PCP)

PCP assists start ups in taking their products from the lab to the market by providing guidance, resources, and funding.

It supports the commercialization of innovative biotech products and technologies.

Regional Centres

BIRAC operates regional innovation centers across India, fostering local innovation ecosystems.

These centers offer mentorship, infrastructure, and support to start ups and entrepreneurs in various regions.

Conclusion

BIRAC stands as a beacon of innovation, guiding India's biotechnology sector towards new horizons of progress. Through strategic programs, partnerships, and a visionary approach, BIRAC empowers researchers, entrepreneurs, and start ups to shape the future of biotechnology. As BIRAC's efforts continue to bear fruit, India's biotech landscape is poised for remarkable transformation, driven by innovation, collaboration, and the pursuit of excellence.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



DBT (Department of Biotechnology)

Established: 1986

Under: Ministry of Science & Technology, Government of India

Headquarters: New Delhi

Main Objectives of DBT:

1. Promote research & innovation in all fields of biotechnology
2. Support biotech industries, start ups, and institutions
3. Strengthen India's capabilities in areas like health, agriculture, environment
4. Provide funding and fellowships for biotech education & training

Key Focus Areas of DBT:

- Agricultural Biotechnology:

GM crops, biofertilizers, disease-resistant varieties

- Medical & Health Biotechnology:

Vaccines (e.g., COVID-19), diagnostics, stem cell therapy, genomics

- Environmental Biotechnology:

Waste treatment, bioremediation, bioenergy

- Industrial Biotechnology:

Enzymes, fermentation, biofuels, bioplastics

- Bioinformatics & Genomics:

Human Genome Project, genome sequencing centers

Major DBT Initiatives & Programs:

- Biotech Ignition Grant (BIG):

For start ups and early-stage biotech ideas

- BIRAC (Biotechnology Industry Research Assistance Council):

Supports biotech industries and entrepreneurs

- Human Resource Development Programs:

DBT-JRF, DBT-RA, MSc & PhD fellowships in biotech

- National Biopharma Mission:



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



To make India self-reliant in vaccine and biopharma development

- Genome India Project:

Large-scale genome mapping across Indian population

DBT Institutions:

Some institutes under DBT:

- National Institute of Immunology (NII), Delhi
- Center for DNA Fingerprinting and Diagnostics (CDFD), Hyderabad
- Institute of Life Sciences (ILS), Bhubaneswar
- National Institute of Biomedical Genomics (NIBMG), Kalyani

Building Scientific Leaders

Over the past five years, DBT's Autonomous Institutions have been instrumental in shaping the next generation of biotechnological leaders. With a commitment to excellence, these institutions have successfully trained over 700 Ph.D. scholars, 1000 post-docs, and 5000 research fellows. Notably, they have contributed significantly to the academic landscape by publishing over 6000 papers and securing 100 patents.

Innovating for National Growth

Beyond scientific achievements, DBT has been crucial in formulating policies and guidelines that profoundly impact India's biotech sector. Beyond mere support, the department has positioned itself as a visionary architect, actively shaping India's biotechnological future trajectory.

A Diverse Ecosystem for Societal Well-being

DBT's influence extends far beyond the confines of research laboratories. The department's expansive support network reaches 15 theme-based autonomous institutions, one international organization, and innovative Public Sector Undertakings like BIBCOL and BIRAC. The numbers speak volumes – with over 6000 research projects, 50,000 scientific personnel, 4 bio clusters, 20 Centres of Excellence, and 10 biotech parks, DBT is committed to building a diverse and impactful ecosystem.

Addressing National Challenges

DBT's initiatives go beyond laboratory breakthroughs; they actively address societal challenges through innovative biotechnological solutions. From healthcare to agriculture and environmental sustainability, DBT-backed research makes a tangible difference in people's lives.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Empowering Start ups for Social Impact

Public Sector Undertakings like BIRAC are fostering a culture of innovation and entrepreneurship. Start ups nurtured by DBT are not just driving economic growth but are also focused on solving critical societal issues. This ensures that the benefits of biotechnological progress reach every corner of the nation, positively impacting society at large.

Humanitarian Initiatives and Global Collaboration

DBT's impact transcends national borders. The department's bilateral partnerships with over 20 countries and collaborations with international organizations underscore India's commitment to global biotechnological progress for the collective good.

Impact of DBT:

- Boosted vaccine research (e.g., Covaxin, ZyCoV-D)
- Supported 1000+ biotech start ups via BIRAC
- Improved biotech education and infrastructure across India

Incubation centers

Biotech incubation centers provide crucial support for life science start ups, offering specialized labs, high-end equipment, mentorship, IP guidance, and networking, with key examples in India including BIRAC-supported incubators like C-CAMP, Bangalore Bioinnovation Centre, and those under the BioNEST program, along with global players like LabCentral and MBC BioLabs, helping transform lab ideas into market-ready products. These centers, often linked to academia or government (DBT, NITI Aayog), focus on resource-heavy biotech needs for faster commercialization.

BIRAC BioNEST (Bioincubators Nurturing Entrepreneurship for Scaling Technologies) is a flagship program by Biotechnology Industry Research Assistance Council (BIRAC) under India's Department of Biotechnology (DBT), designed to create world-class bio-incubation facilities across India to support and scale biotech start ups, providing crucial infrastructure, high-end instruments, and mentorship for translating innovative ideas into commercial products in healthcare, agriculture, and industry. It acts as a vital platform, offering physical space, shared facilities, and networking for young biotech entrepreneurs, fostering the nation's vibrant biotech ecosystem.

Key Aspects of BioNEST:

Goal: To establish a robust network of bio-incubators that nurture biotech innovation and help start ups scale up.

Support Provided: Incubation space, advanced instrumentation access, mentorship, networking with peers and experts, and linking innovation to commercialization.



ACADEMIC YEAR 2025-2026, SEMESTER – VI STUDY MATERIAL FOR B.Sc. MICROBIOLOGY BIO ENTREPRENEURSHIP AND BIOBUSINESS



Implementation: Supports setting up standalone incubators or integrating them within academic institutions (like universities or research centers).

Impact: Has supported the creation of numerous bio-incubators, significantly expanding infrastructure for biotech entrepreneurs nationwide.

Focus Areas: Med-tech, Health-tech, Agriculture Biotech, Industrial Biotech, and more, aligning with national initiatives like Start up India.

In essence, BioNEST provides the critical "landing space" and resources that biotech start ups need, bridging the gap between lab-based research and market-ready technologies.

Centre for Cellular and Molecular Platforms (C-CAMP) – Overview

The Centre for Cellular and Molecular Platforms (C-CAMP) an initiative supported by Department of Biotechnology, Govt of India is a catalyst of cutting-edge research and innovation in the life sciences since 2009. They facilitate Bioscience Research and Entrepreneurship by providing Research, Development, Training and Services in state-of-the-art Technology Platforms.

C-CAMP allows Investigators to use Techniques as tools and not be limited by Technological barriers while pursuing challenging scientific questions.

Location: Bengaluru, Karnataka

Established by: Department of Biotechnology (DBT), Government of India

Type: Biotechnology innovation and incubation hub

Key Functions:

1. Incubation Support:

- Provides infrastructure and mentorship to biotech start ups.
- Focus areas: life sciences, healthcare, diagnostics, agriculture biotech, etc.
- Hosts BioNEST incubator supported by BIRAC.

2. Funding Programs:

- C-CAMP manages seed funding schemes like:
 - BIG (Biotechnology Ignition Grant)
 - Leap Fund
 - Equity-based funding

3. Technology Platforms:

- High-end facilities in:



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



- Genomics
- Proteomics
- Imaging
- Flow cytometry
- Genome editing (CRISPR)
- Mass spectrometry, etc.

4. Mentorship & Networking:

- Connects start ups with domain experts, industry leaders, and venture capitalists.

5. Innovation Promotion:

- Runs challenges and programs for early innovation (e.g., C-CAMP AMR, MedTech Challenge).

Notable Impact:

- Incubated over 200+ start ups
- Enabled innovations in public health, agriculture, bio-therapeutics, etc.

The CDFD Technology Incubator in Hyderabad, part of the renowned Centre for DNA Fingerprinting and Diagnostics (CDFD), nurtures early-stage deep-tech start ups in life sciences with specialized support, including zero-equity models, access to cutting-edge genomics/diagnostics expertise, and unique in-house animal facilities for preclinical work, located within Hyderabad's thriving biotech corridor to accelerate innovation in health and biotech.

Key Features & Offerings:

Focus: Life sciences, biotechnology, diagnostics, genomics, and related deep-tech innovation.

Support Model: Founder-friendly, offering incubation without equity dilution.

Unique Advantage: Exclusive access to CDFD's in-house animal facility for animal studies and toxicity testing, speeding up development.

Expertise: Leverages CDFD's strong foundation in genomics and molecular diagnostics.

Services: R&D support, business incubation, technology transfer, mentoring, IP facilitation, funding help, and coworking space.

Location: Situated in the growing health corridor of Eastern Hyderabad (Uppal), near other academic and industry players.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Who It's For:

Early-stage start ups and entrepreneurs working on innovative solutions in biotech, healthcare, diagnostics, and life sciences.

Operational biotech parks in india

The Department of Biotechnology (DBT) has partnered with various State Governments to establish Biotech Parks since 2003. It has helped to translate research into products and services by providing necessary infrastructure support. These parks are successfully accelerating the commercialization of new technologies, assisting new enterprises to forge appropriate linkages with other stakeholder of biotechnology sector including academia, industry and Government. DBT has supported establishment of nine Biotechnology Parks in different State and UTs. The details are given below:

S. No.	State	Current status of proposal
1.	Telangana	The proposal has been approved by the Department
2.	West Bengal	DBT-Scheme Steering Committee (SSC) recommended the proposal in –principle and has suggested for setting up of a SPV for the Biotech Park. Response of State S&T Council is awaited.
3.	Karnataka (c-CAMP)	DBT-SSC suggested revision of proposal. Revised proposal is awaited.
4.	Madhya Pradesh	DBT-SSC suggested revision of proposal. Revised proposal to be considered in next meeting of DBT-SSC
5.	Himachal Pradesh	DBT-SSC suggested revision of proposal. Revised proposal to be considered in next meeting of DBT-SSC
6.	Andhra Pradesh (AMTZ)	The proposal is under consideration for support
7.	Andhra Pradesh (Science City)	Proposal Not Recommended by SSC

This was stated by Union Minister of Science & Technology, Earth Sciences and Health & Family Welfare, Dr. Harsh Vardhan in Rajya Sabha today.

Services by BCIL

BCIL has assisted various state governments in preparing project reports for setting up of biotech parks. The report includes identifying and prioritization of the biotechnology sector for which



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



state offers unique advantages, recommending specialized biotech facilities to promote entrepreneurship and attract investments, suggesting management model and working out financial feasibility. BCIL extends advisory services in setting up and operationalization of Biotech Parks/Incubators:

Services in setting up of Biotech Parks/Incubators

Engineering consultancy: Preparation of various design, detailed engineering drawing & specifications, Bill of Quantity, tender document and assistance in floating tender.

Advisory/monitoring services: Selection of contractors and monitoring of implementation of Biotech Park/Incubator.

Equipment Consultancy: Preparation of detailed specification of equipment, monitoring of procurement of equipment, performance analysis and validation.

Operational Services

Services to Incubators

Selection of suitable incubates

Widespread awareness Creation

Review of Business Plans

Execution of Agreements between Incubator and Incubatees

Monitoring the Progress of Incubatees

Services to Incubatees

Mentoring Services

Access to technical expertise for trouble shooting

Guidance for accessing fund source

Training

IP Management

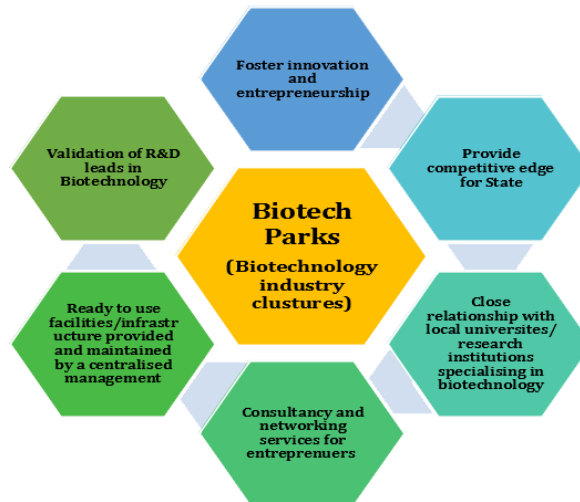
Business Management

Advisory on market access

Techno-legal Management



ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS



Indian Companies Act

The Indian Companies Act, primarily The Companies Act, 2013, is India's main law governing company formation, operations, and dissolution, replacing the older Companies Act, 1956, to align with modern economic needs. Key features include mandatory Corporate Social Responsibility (CSR), One Person Companies (OPCs), enhanced director responsibilities, and provisions for auditors, mergers, and tribunals, ensuring comprehensive regulation for listed and unlisted companies across India.

1. Indian Companies Act, 2013 – Foundation for Biotech Start ups

This Act regulates how companies are formed, governed, and run in India — including biotech businesses

Key Points:

- A biotech business must register under this Act to be recognized as a company.
- Preferred structure: Private Limited Company (helps in raising funds and availing government schemes).
- Requires registration on Ministry of Corporate Affairs (MCA) portal.

2. Once Registered – Access to Schemes and Subsidies

Once the biotech company is registered, it becomes eligible for various government incentives, especially from DBT, BIRAC, and Start up India.

3. Major Schemes for Biotech Companies

A. DBT/BIRAC Schemes

- BIG (Biotechnology Ignition Grant) – ₹50 lakh for idea-to-prototype stage.
- SBIRI – Support for innovation in small biotech businesses.



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



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- PACE – Special scheme for women/SC/ST-led biotech start ups.
 - BioNEST – Incubation support with lab access.

B. Start up India (under DPIIT)

- Tax exemption for 3 years
- Fast-track patent application
- Easier public procurement access
- Start up India Seed Fund Scheme

C. MSME Schemes (If registered as Udyam)

- Credit Guarantee Scheme – Collateral-free loans
- Technology Upgradation Subsidy
- ZED certification – For quality & sustainability

4. Compliance Under Company Act Is Must

To access all these schemes:

- File annual returns with ROC
- Maintain proper records
- Stay compliant with tax & audit norms

Project Proposal

What is a Project Proposal?

A project proposal is a document drafted by the team who is responsible for the initialization of the project. The project proposal comprises the aim of the project, methodology, budget required, timeline, and the results.

The project proposal is developed before the initiation of the project and is presented before the clients so that the clients can analyze the funding, time, and output.

It serves as a communication tool to convey the project's objectives, scope, methodology, and resource requirements to stakeholders.

Clearly defines the purpose and context of the project proposal.

Introduces the project, its objectives, and the problem or opportunity it addresses.

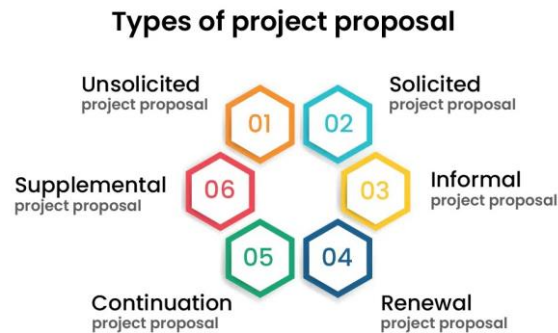
Objective to make a Project Proposal

Secure external funding.



Convince executives to allocate resources to your project.

Drive innovation.



How to Write a Project Proposal?

Steps 1. Write an Executive Summary

The executive summary provides a quick overview of the main points of your project proposal, such as your project background, project objectives project deliverables, etc. The goal is to catch the attention of your audience and get them excited about your project. The executive summary should show a picture of what project success looks like for the client.

Steps 2. Provide a Project Background

In this section of your project proposal, you try to explain the problem that your project will solve. You are required to explain to the reader that the issue you are addressing is worth it, you can use historical data to prove your point and how your solution is an ideal solution for the problem.

Steps 3. Establish a Project Vision and Success Criteria

You are required to define your project vision to show what you want to achieve, and what are your goals. It's also essential to set up success criteria to show that the project is on the right path. There should be parameters according to which you can measure the success of your project and ensure that you are working towards the success of your project.

Steps 4. Identify Potential Risks and Mitigation Strategies

To lower the impact of risk in your project, you need to identify what those risks are that you might face in the future during the project and should develop plans to tackle them. Prepare a list of all the possible risks that might occur, prioritize them, describe what you'll do to mitigate or take advantage of them, and who on the team is responsible for keeping an eye out for them and solving them.



Steps 5. Explain your Project Approach

Your project approach defines the project management methodology, tools, and governance for your project. In simple terms, it allows project managers to explain to stakeholders how the project will be planned, executed, and controlled successfully.

Steps 6. Identify Project Resource Requirements

Project resources play an important role in the development and completion of a project. When we work on projects there are various items, materials, and resources are required at a specific time, so it is essential that those resources are provided at that time for the project so the project can be completed. We are required to identify the requirement of these resources, the time at which they needed quantity and mention all these details in a proposal for the project.

Steps 7. Estimate Project Costs and Project Budget

Resources are limited and come with a price, every time there is a budget passed for the project. So, you are required to estimate the right cost of the project and make the use of resources effectively. You are required to mention the details of your estimated cost in the proposal and also it is required that while preparing your project budget you should adhere to the organization's budget as well.

Steps 8. Define a Project Timeline

Project timeline refers to the time taken by each task or phase of the project. A project is divided into various phases, you are required to prepare a timeline for the project in which you mention how much time is required for each phase and the estimated time in which the project will be completed. So you can match your estimated timeline with the actual time taken during the different steps or phases to check whether your project is going at the right pace or not.

Tips for Writing an Effective Project Proposal



- 01 Do Proper Research
- 02 Keep it Simple
- 03 Pay Attention to Others Perspectives as Well
- 04 Follow the Guidelines
- 05 Use Project Management Tools to Strengthen Your Project Proposal

Successful start ups case study

1. Bharat Biotech International Ltd. (Hyderabad)

Founder: Dr. Krishna Ella



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Established: 1996

Specialization: Vaccine development & manufacturing

Key Products:

- Covaxin: India's first indigenous COVID-19 vaccine (with ICMR & NIV)
- Vaccines for Rotavirus (Rotavac), Typhoid (Typbar TCV), Hepatitis B

Achievements:

- Over 145 global patents
- Supplies vaccines to over 100 countries
- WHO prequalification for many vaccines

Support & Recognition:

- DBT support, ICMR collaboration
- Padma awards to founders
- Global recognition post-COVID

Success Factors:

- Strong R&D investment
- Public-private partnerships
- In-house manufacturing facilities

2. Biocon Ltd. (Bengaluru)

Founder: Kiran Mazumdar-Shaw

Established: 1978

Specialization: Biopharmaceuticals – insulin, biosimilars, monoclonal antibodies

Key Milestones:

- First Indian company to manufacture recombinant human insulin
- Products approved by US FDA, EMA, and WHO
- Publicly listed company

Global Reach:

- Supplies to over 120 countries
- Collaborates with Mylan, Viatrix, and global pharma companies



**ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS**



Support:

- DBT and international collaborations
- Recognized as a global innovator in affordable biopharma

Success Factors:

- Early mover in biotech
- Global compliance & quality
- Leadership in biosimilars

3. Serum Institute of India (Pune)

Founder: Dr. Cyrus Poonawalla

Established: 1966

Specialization: Vaccines

Achievements:

- World's largest vaccine manufacturer by volume
- Major producer of DTP, MMR, BCG, and COVID-19 vaccines (Covishield)
- Exporter to 150+ countries, including WHO programs

Role in COVID-19:

- Partnered with Oxford-AstraZeneca for Covishield
- Played major role in India's and global vaccination drive

Success Factors:

- Massive production capacity
- Focus on affordable vaccines
- Collaboration with international bodies

4. String Bio (Bengaluru)

Founded: 2013

Founders: Dr. Ezhil Subbian and team

Specialization: Industrial biotech, methane to protein (alternate protein)

Innovation:

- Uses methane gas to produce protein-rich biomass for animal feed & agriculture



-
- Sustainable and carbon-negative approach

Recognition:

- Funded by Gates Foundation, BIRAC, Blue Horizon Ventures
- Incubated at C-CAMP (DBT initiative)

Success Factors:

- Climate-friendly biotech model
- Scalable synthetic biology process
- Global investor interest

5. Sea6 Energy (Bengaluru)

Founded: 2010 by IIT Madras alumni

Specialization: Marine biotech – Seaweed-based products

Products:

- Biostimulants, biofertilizers
- Seaweed-based extracts for sustainable agriculture

Innovation:

- Developed automated seaweed cultivation system
- Converts marine biomass to valuable agri-products

Recognition:

- Funding from Tata Capital, BASF
- Support from DBT-BIRAC, BioNEST incubators

Success Factors:

- Untapped marine biotech sector
- Sustainable and scalable model
- Innovation in ocean farming

Key Themes in Indian Biotech Success:

Niche Solutions: Targeting specific unmet needs (e.g., resistant infections, organ shortages).

Technology Integration: Using AI, ML, and bioprinting to innovate.

Strong Funding: Attracting venture capital and government grants (SBIRI).



ACADEMIC YEAR 2025-2026, SEMESTER – VI
STUDY MATERIAL FOR B.Sc. MICROBIOLOGY
BIO ENTREPRENEURSHIP AND BIOBUSINESS



Addressing Public Health: Creating solutions for widespread issues like antibiotic resistance, diagnostics, and rural healthcare.

KAMARAJ WOMENS COLLEGE