

## Lecture 4: Fermentation and Biotechnology

### Fermentation Applications

- The fermentation industry reaches back to 5000 BCE.
  - Date of a Neolithic jar containing wine
  - Today, product enzymes are made by bacteria grown in giant fermentation vessels.
- Fermentation allows food to last longer
- Bacteria can be used to alter growth factors, fermenters keep going until conditions kill them → as well as competing bacteria

### Microbes as Food

#### Edible fungi

- Mushrooms: Fungal fruiting bodies
  - Source of proteins and minerals
  - Underground truffles
  - *Agaricus bisporus*: button and portobellos
  - Quorn - *Fusarium venenatum*
  - Protein substitute → has higher nucleic acid concentration that triggers gout

#### Edible Algae (seaweed)

- Red algae *Porphyra*
  - Nori (sushi)
- Brown algae *Macrocystis*
  - Alginate

#### Edible Bacteria

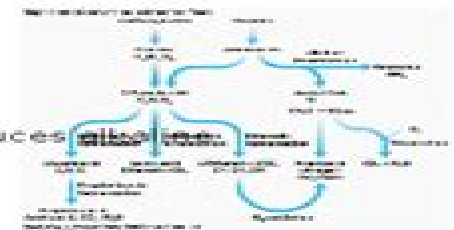
- Nucleic acid often too concentrated for food
- Cyanobacterium Spirulina*:
- Single-celled protein

### Applications of Fermentation

#### Overview of Fermented Foods

- Virtually all human cultures have developed varieties of fermented foods, which are food products modified biochemically by microbial growth.
- The purposes of food fermentation include:
  - To preserve food: By limiting microbial growth → improve longevity
  - To improve digestibility: By breaking down fibers
    - Microbes as able to predigest; break down complex compounds → easily gain the nutrients
  - To add nutrients (such as vitamins) and flavor molecules (such as esters and sulfur compounds)
- Traditional fermented foods usually depend on indigenous flora (found naturally in the food) or starter cultures (from a previous fermentation).
  - Natural fermentation use the local microbes to undergo fermentation → instead of starter cultures and (more defined products and outcome → GMO to increase yield)
- Major classes of fermentation reactions include:
  - Homolactic acid fermentation
  - Propionic acid fermentation
  - Heterolactic acid fermentation
  - Ethanolic fermentation
  - Alkaline fermentation
- If organism does not have sugars → breaks down AA produces

Product	Microorganism	Standard product	Geographic origin
Alcoholic fermentation of starch products, meat, and fish			
Brewery	<i>Saccharomyces cerevisiae</i>	Beer	Germany, USA
Wine	<i>Saccharomyces cerevisiae</i>	Wine	France, Italy, USA
Distilled spirits	<i>Saccharomyces cerevisiae</i>	Whisky, Vodka, Rum, Brandy	Scotland, Poland, Russia, France
Beer	<i>Saccharomyces cerevisiae</i>	Beer	Germany, USA
Wine	<i>Saccharomyces cerevisiae</i>	Wine	France, Italy, USA
Distilled spirits	<i>Saccharomyces cerevisiae</i>	Whisky, Vodka, Rum, Brandy	Scotland, Poland, Russia, France
Meat	<i>Lactobacillus</i>	Sauerkraut, Pickled vegetables	Germany, Poland, Russia, France
Fish	<i>Lactobacillus</i>	Sauerkraut, Pickled vegetables	Germany, Poland, Russia, France
Alcoholic fermentation of other carbohydrates			
Beer	<i>Saccharomyces cerevisiae</i>	Beer	Germany, USA
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Fish	<i>Lactobacillus</i>	Sauerkraut, Pickled vegetables	Germany, Poland, Russia, France



# Fermentation Technology Lecture Notes

**Hans Schuler**



## **Fermentation Technology Lecture Notes:**

*Microbiology Class Notes* Tramar F. Murdock, 2015-08-11 Microbiology Class Notes takes a comprehensive look at Microbiology and gives one the big picture. Time for studying is at a premium and for that reason it is important to study effectively. Unless one can remember EVERYTHING in Microbiology for the big exam you want to use these notes. These notes are intended for the Medical Graduate Nursing or Undergraduate student.

**Enhancing Nutrient Profile, Safety, and Sustainability with Fermentation Technology** Xi Feng, John Gieng, Oluwafemi Ayodeji Adebo, 2025-03-10 Fermentation is a metabolic process that improves the nutrition density of foods. It can convert food components to small molecules through enzymatic action. Historically many foods have undergone fermentation including meat, fish, dairy, vegetable, soybeans, etc. to enhance a variety of qualities including but not limited to nutrition content, safety, and preservation, sustainability, appearance, texture, aroma, and flavor. Fermentation as a processing technology has been utilized for thousands of years; however, limited research is available to develop optimized and cost-effective methods to utilize fermentation to improve nutrient bioavailability while also considering sustainability and food safety. These gaps limit the development and commercialization of sustainable, nutrient-rich fermented foods and access to these healthy foods.

**Prozeßsimulation** Hans Schuler, 2008-11-25 Die Prozeßsimulation entwickelt sich zu einem immer wichtigeren Werkzeug der Verfahrenstechnik. Prozeßsimulationen werden heute in allen Phasen des Lebenszyklus von Prozessen eingesetzt. Von der Verfahrensentwicklung über die Auslegung und Planung bis in den Betrieb chemisch-verfahrenstechnischer Prozesse begleiten heute Simulationen die Arbeit der Ingenieure. Der Preisverfall der Rechenleistung von Computern und Fortschritte in den Basiswissenschaften der Modellierung und Numerischen Mathematik begünstigen einen breiteren Einsatz der Simulationstechnik in vielen Bereichen. Dieses Buch stellt die Grundlagen, den derzeitigen Entwicklungsstand und trend der Prozeßsimulation dar. Es kann als Leitfaden und Orientierung für das Gebiet dienen und helfen, das Potential dieser Methode einzuordnen. Von anderen Werken über Simulationstechnik unterscheidet sich das vorliegende durch die Konzentration auf ein wichtiges Anwendungsgebiet: die Simulation verfahrenstechnischer Prozesse. Diese Beschränkung der Simulationstechnik auf diesen Bereich spiegelt die hohe strategische Bedeutung wider.

**Comprehensive Biotechnology: The principles of biotechnology**, 1985  
**Comprehensive Biotechnology: The principles of biotechnology** Murray Moo-Young, 1985 V 1 The principles of biotechnology Scientific fundamentals v 2 The principles of biotechnology Engineering considerations v 3 The practice of biotechnology Current commodity products v 4 The practice of biotechnology Speciality products and service activities

*Process Biotechnology* S. N. Mukhopadhyay, 2012-01-01 Rapid progress has been made in the discipline of biochemical engineering and biotechnology for bioprocess development during the last 50 years. Process Biotechnology theory and practice has been written with the consideration that tutorial practice is as important as understanding the subject theoretically. This book is an introductory tutorial book involving multidisciplinary principles. Principal innovations that have

been made in biosystem related developments have been emphasized through tutorials in this book The first few chapters cover theoretical aspects of biochemical and chemical engineering concerns in biotechnological advances in a concise manner The rest have been dedicated to the tutorial aspects of this multidisciplinary subject This book covers biological ecological chemical and biochemical engineering topics related to the subject It provides much needed theory based solved numerical problems for practice in quantitative evaluation of various parameters relevant to process biotechnology It will be useful for students who would like to further their careers as biotechnologists and can be used as a self study text for practicing engineers biotechnologists microbiologists and scientists involved in bioprocessing research and other related fields

**Proceedings of the NIELIT's International Conference on Communication, Electronics and Digital Technology** Isaac Woungang, Sanjay Kumar Dhurandher, Yumnam Jayanta Singh, 2024-07-30 The book presents selected papers from NIELIT s International Conference on Communication Electronics and Digital Technology NICEDT 2024 held during 16 17 February 2024 in Guwahati India The book is organized in two volumes and covers state of the art research insights on artificial intelligence machine learning big data data analytics cybersecurity and forensic network and mobile security advance computing cloud computing quantum computing VLSI and semiconductors electronics system Internet of Things robotics and automations blockchain and software technology digital technologies for future and assistive technology for Divyangjan people with disabilities

*Technology Innovation in Mechanical Engineering* Prem Kumar Chaurasiya, Abhishek Singh, Tikendra Nath Verma, Upendra Rajak, 2022-04-29 This book comprises select papers presented at the conference on Technology Innovation in Mechanical Engineering TIME 2021 The book discusses the latest innovation and advanced research in the diverse field of Mechanical Engineering such as materials manufacturing processes evaluation of materials properties for the application in automotive aerospace marine locomotive and energy sectors The topics covered include advanced metal forming Energy Efficient systems Material Characterization Advanced metal forming bending welding casting techniques Composite and Polymer Manufacturing Intermetallics Future generation materials Laser Based Manufacturing High Energy Beam Processing Nano materials Smart Material Super Alloys Powder Metallurgy and Ceramic Forming Aerodynamics Biological Heat Mass Transfer Combustion Propulsion Cryogenics Fire Dynamics Refrigeration Air Conditioning Sensors and Transducers Turbulent Flows Reactive Flows Numerical Heat Transfer Phase Change Materials Micro and Nano scale Transport Multi phase Flows Nuclear Space Applications Flexible Manufacturing Technology System Non Traditional Machining processes Structural Strength and Robustness Vibration Noise Analysis and Control Tribology In addition it discusses industrial applications and cover theoretical and analytical methods numerical simulations and experimental techniques in the area of Mechanical Engineering The book will be helpful for academics including graduate students and researchers as well as professionals interested in interdisciplinary topics in the areas of materials manufacturing and energy sectors

Handbook of Sourdough Microbiota and Fermentation Fatih Ozogul, João Miguel

Rocha,Elena Bartkiene,2024-10-23 Handbook of Sourdough Microbiota and Fermentation Food Safety Health Benefits and Product Development links the cereal and sourdough based microorganisms fermentations and microbial metabolites with food hygiene and safety functional and health promoting properties and their potential interest to be employed in the agro food sector and beyond Structured in a way that provides the latest findings and most recent approaches and trends on sourdough this book also emphasizes the biotechnological aspects such as fermentation food processing and the use of beneficial microorganisms and their metabolites in different ways and in different industries Written by experts from a multidisciplinary perspective this book is a remarkable reference to a wide range of audiences with different backgrounds from academics and researchers in food science to industrial food engineers and technicians food plant managers and new product and processing developers managers in food packaging and preservation Covers how cereal based and sourdough microorganisms and microbial metabolites can be used to extend the shelf life of bread and other agro food products Presents microbial safety fermentations ropiness of baking based products bacterial and mold food spoilage and the health promotion of sourdough and cereal based products Describes how cereal and sourdough based products can contribute to convenient nutritious stable natural low processed and healthy food Innovative Computing and Communications Aboul Ella Hassanien,Sameer Anand,Ajay Jaiswal,Prabhat Kumar,2024-07-26 This book includes high quality research papers presented at the Seventh International Conference on Innovative Computing and Communication ICICC 2024 which is held at the Shaheed Sukhdev College of Business Studies University of Delhi Delhi India on 16 17 February 2024 Introducing the innovative works of scientists professors research scholars students and industrial experts in the field of computing and communication the book promotes the transformation of fundamental research into institutional and industrialized research and the conversion of applied exploration into real time applications Advances in Automation, Signal Processing, Instrumentation, and Control Venkata Lakshmi Narayana Komanapalli,N. Sivakumaran,Santoshkumar Hampannavar,2021-03-04 This book presents the select proceedings of the International Conference on Automation Signal Processing Instrumentation and Control i CASIC 2020 The book mainly focuses on emerging technologies in electrical systems IoT based instrumentation advanced industrial automation and advanced image and signal processing It also includes studies on the analysis design and implementation of instrumentation systems and high accuracy and energy efficient controllers The contents of this book will be useful for beginners researchers as well as professionals interested in instrumentation and control and other allied fields *Proceedings of the 2nd International Conference on Intelligent Technologies and Engineering Systems (ICITES2013)* Jengnan Juang,Cheng-Yi Chen,Cheng-Fu Yang,2014-04-18 This book includes the original peer reviewed research papers from the conference Proceedings of the 2nd International Conference on Intelligent Technologies and Engineering Systems ICITES2013 which took place on December 12 14 2013 at Cheng Shiu University in Kaohsiung Taiwan Topics covered include laser technology wireless and mobile networking lean and agile

manufacturing speech processing microwave dielectrics intelligent circuits and systems 3D graphics communications and structure dynamics and control      ***Advances in Applied Biotechnology*** Tong-Cun Zhang,Motowo Nakajima,2015-01-19 At the ICAB 2014 researchers from around the world will gather to discuss the latest scientific research findings and technologies concerning Microbial Genetics and Breeding Optimization and Control of Biological Processes Biological Separation and Biological Purification and Advances in Biotechnology This conference will provide a platform for academic exchange on the application of biotechnology between domestic and international universities research institutes corporate experts and scholars The participants will focus on the international development and future trends The event will lay a solid foundation for addressing key technical challenges in various areas of applied biotechnology providing opportunities to promote the development and expansion of the biotechnology industry      ***Advances in Applied Biotechnology*** Hao Liu,Cunjiang Song,Arthur Ram,2017-10-07 This book presents and discusses the latest advances in biotechnology and selected challenges and opportunities in connection with its industrial applications It gathers the proceedings of the 3rd International Conference on Applied Biotechnology ICAB2016 held on November 25 27 2016 in Tianjin China which continued the success of the previous biennial ICAB conferences providing a platform for scientists and engineers to exchange ideas about the frontiers of biotechnology Topics include but are not limited to microbial genetics and breeding biological separation and purification optimization and control of biological processes and advances in biotechnology Offering key insights into the latest breakthroughs the book is intended for industrial leaders professionals and research pioneers in the field of applied biotechnology      ***Handbook of Fermented Meat and Poultry*** Fidel Toldrá,2008-04-15 An internationally respected editorial team and array of chapter contributors has developed the Handbook of Fermented Meat and Poultry an updated and comprehensive hands on reference book on the science and technology of processing fermented meat and poultry products Beginning with the principles of processing fermented meat and ending with discussions of product quality safety and consumer acceptance the book takes three approaches background and principles product categories and product quality and safety The historical background on the fermentation of meat and poultry products is followed by a series of discussions on their science and technology curing fermentation drying and smoking basic ingredients raw product additives spices and casings and starter cultures Coverage of product categories details the science and technology of making various fermented meat and poultry products from different parts of the world including semidry fermented sausages summer sausage dry fermented sausages salami sausages from other meats and ripened meat products ham Product quality and safety is probably the most important aspect of making fermented meat and poultry because it addresses the question of consumer acceptance and public health safety While a processor may produce a wonderful sausage the product must ultimately satisfy the consumer in terms of color texture taste flavor packaging and so on In the current political and social climate food safety has a high priority Coverage includes issues such as spoilage microorganisms pathogens amines toxins HACCP and disease

outbreaks      **Bioreactor Immobilized Enzymes and Cells** Murray Moo-Young,1988-01-11      *Research in Computer Science in the Bulgarian Academy of Sciences* Krassimir T. Atanasov,2021-07-19 This book is a collection of papers devoted to the emergence and development in Bulgarian Academy of Sciences of some of the areas of informatics including artificial intelligence The papers are prepared by specialists from the Academy some of whom are among the founders of these scientific and application areas in Bulgaria and in some cases in the world The book is interesting for specialists in informatics and computer science and researchers in history of sciences      **Intelligent Control in Drying** Alex Martynenko,Andreas Bück,2018-09-03 Despite the available general literature in intelligent control there is a definite lack of knowledge and know how in practical applications of intelligent control in drying This book fills that gap Intelligent Control in Drying serves as an innovative and practical guide for researchers and professionals in the field of drying technologies providing an overview of control principles and systems used in drying operations from classical to model based to adaptive and optimal control At the same time it lays out approaches to synthesis of control systems based on the objectives and control strategies reflecting complexity of drying process and material under drying This essential reference covers both fundamental and practical aspects of intelligent control sensor fusion and dynamic optimization with respect to drying

*Artificial Neural Networks in Food Processing* Mohamed Tarek Khadir,2021-01-18 Artificial Neural Networks ANNs is a powerful computational tool to mimic the learning process of the mammalian brain This book gives a comprehensive overview of ANNs including an introduction to the topic classifications of single neurons and neural networks model predictive control and a review of ANNs used in food processing Also examples of ANNs in food processing applications such as pasteurization control are illustrated      Power Electronics and Renewable Energy Systems C. Kamalakannan,L. Padma Suresh,Subhransu Sekhar Dash,Bijaya Ketan Panigrahi,2014-11-19 The book is a collection of high quality peer reviewed research papers presented in the Proceedings of International Conference on Power Electronics and Renewable Energy Systems ICPERES 2014 held at Rajalakshmi Engineering College Chennai India These research papers provide the latest developments in the broad area of Power Electronics and Renewable Energy The book discusses wide variety of industrial engineering and scientific applications of the emerging techniques It presents invited papers from the inventors originators of new applications and advanced technologies

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## **Table of Contents Fermentation Technology Lecture Notes**

1. Understanding the eBook Fermentation Technology Lecture Notes
  - The Rise of Digital Reading Fermentation Technology Lecture Notes
  - Advantages of eBooks Over Traditional Books
2. Identifying Fermentation Technology Lecture Notes
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Fermentation Technology Lecture Notes
  - User-Friendly Interface
4. Exploring eBook Recommendations from Fermentation Technology Lecture Notes
  - Personalized Recommendations



- Fermentation Technology Lecture Notes User Reviews and Ratings
- Fermentation Technology Lecture Notes and Bestseller Lists
- 5. Accessing Fermentation Technology Lecture Notes Free and Paid eBooks
  - Fermentation Technology Lecture Notes Public Domain eBooks
  - Fermentation Technology Lecture Notes eBook Subscription Services
  - Fermentation Technology Lecture Notes Budget-Friendly Options
- 6. Navigating Fermentation Technology Lecture Notes eBook Formats
  - ePub, PDF, MOBI, and More
  - Fermentation Technology Lecture Notes Compatibility with Devices
  - Fermentation Technology Lecture Notes Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Fermentation Technology Lecture Notes
  - Highlighting and Note-Taking Fermentation Technology Lecture Notes
  - Interactive Elements Fermentation Technology Lecture Notes
- 8. Staying Engaged with Fermentation Technology Lecture Notes
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Fermentation Technology Lecture Notes
- 9. Balancing eBooks and Physical Books Fermentation Technology Lecture Notes
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Fermentation Technology Lecture Notes
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Fermentation Technology Lecture Notes
  - Setting Reading Goals Fermentation Technology Lecture Notes
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Fermentation Technology Lecture Notes
  - Fact-Checking eBook Content of Fermentation Technology Lecture Notes

- Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
- 14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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