Unit Name: #2 Industrial Benefits of Microorganisms **Course: Microbiology**
Grade Level: Junior/Senior **Approximate Time: 4 weeks**

BIG IDEAS:

- Industrial Benefits of Microorganisms
  - Food Microbiology
  - Medical Microbiology
  - Environmental Equilibrium
  - Bioengineering and Careers

STAGE ONE: DESIRED RESULTS

ESTABLISHED GOALS

National Science Content Standard: Unifying Concepts and Processes
Conceptual and procedural themes unify science disciplines and provide students with powerful ideas to help them understand the natural world. (Constancy, Change, and Measurement) (Form & Function)
National Science Content Standard: Science and Technology
As a result of their Pre-K-12 schooling, all students should develop abilities of technological design and understandings about science and technology.
Illinois Learning Standard 11.B: Know and apply the concepts, principles and processes of technological design.
Illinois Learning Standard 13.A: Know and apply the accepted practices of science.
Illinois Learning Standard 13.B: Know and apply concepts that describe the interaction between science, technology and society.
National Science Content Standard: History and Nature of Science
As a result of their Pre-K - 12 schooling, all students should develop understanding of: science as a human endeavor, the nature of scientific knowledge, and historical perspectives.
Illinois Learning Standard 13.A: Know and apply the accepted practices of science. (Validity)
Illinois Learning Standard 13.B: Know and apply concepts that describe the interaction between science, technology and society.
National Science Content Standard: Life Science – Form & Function and Interdependence
As a result of their Pre-K – 12 schooling, all students should develop an understanding of: the cell, the molecular basis of heredity, biological evolution, the interdependence of organisms, matter, energy, and organization in living systems, and the behavior of organisms.
Illinois Learning Standard 12.A: Know and apply concepts that explain how living things function, adapt and change.
Illinois Learning Standard 12.B: Know and apply concepts that describe how living things interact with each other and with their environment.

ESSENTIAL QUESTIONS

- How are microorganisms beneficial in everyday life?
- How can microorganisms be utilized to improve the quality of life?
- How are microorganisms linked to each other and their environments?
- How can developments in technology allow for advancements in uses of microorganisms in everyday life?

ENDURING UNDERSTANDINGS

- Interactions between organisms may be for nourishment, reproduction, or protection and may benefit one of the organisms or both of them. Some species have become so dependent on each other that neither could survive without the other.
- Microorganisms are a part of the earth's ecosystems and have a major impact on other species and their environments.
- Human activities can, deliberately or inadvertently, alter the state of microbial equilibrium in ecosystems.
- Many factors in bioengineering can impact the beneficial use of microorganisms.
- Biotechnological design in microbiology is driven by the need to meet human needs and solve human problems.
- Ethical use of microbes is an important aspect of science.
- Societal, cultural, and personal beliefs influence science, specifically bioengineering and advancements in technology.

CORE KNOWLEDGE

- Some microbes cause disease, but most have vital roles in ecosystems and may provide useful products for humans.
- Bacteria play an important role in the environment, industry, and scientific research.
- Protists are important in many foods, in industrial and consumer products, and in scientific research.
- Many microorganisms have symbiotic relationships with other living organisms.
- Fungi play important ecological roles by decomposing organic matter and by breaking down and absorbing minerals from rocks and soil.
- Fungi are used for food, medicines, research, alternative fuels, and pest control.
- Viruses are used as an important tool in biomedical, industrial and environmental research.

ESSENTIAL VOCABULARY

Food Microbiology:
Pasteurization
Radiation
Desiccation/Dehydration
High-pressure preservation
Fermentation
Malting
Perishable
Semi-perishable
Non-perishable

Medical Microbiology:
Pharmaceuticals
Chemotherapy
Antibiotics
Selective toxicity
Bactericidal

SCIENCE PROCESS SKILLS

- Demonstrate proper lab techniques.
- Evaluate advanced bioengineering techniques.
- Create scientific illustrations with proper labeling.
- Conduct valid scientific research in an area of microbiology.
- Debate the pros and cons of medical bioengineering procedures.
- Predict outcomes of specified case studies.

HABITS OF MIND

- **Values and Attitudes**

  Honesty
  Honesty is highly prized in the scientific community and essential to the scientific way of thinking and doing. In school there are numerous opportunities to show what honesty means and how it is valued.

  Curiosity
  By fostering student curiosity, teachers can help students uncover ways to find answers to questions about how the world works.

  Openness to New Ideas
  New ideas are essential for the growth of science. Science education should help all students understand the great importance of carefully considering ideas that at first may seem troublesome to them or at odds with what they generally believe.

  Informed Skepticism
  Science is characterized as much by skepticism as by openness. Science education can help students see the social value of systematic skepticism and develop a healthy balance in their own minds between openness and skepticism.

Bacteriostatic
Plasmids
Conjugation
Transposon
Transformation
Sterilization
Aseptic technique

Environmental Microbiology:
Biogeochemical cycles
Lichen
Mycorrhizae
Nitrogen fixation
Saprobes
Symbiosis
Mutualism
Chemical recycling
Composting
Decomposer
Biofuels
Biomass
Ethanol
Humus
Bioremediation
Potable water
Indicator bacteria
Biosensors
Sludge
Septic tank

Biotechnology:
Biotechnology
Genetic engineering
PCR
Ligase
Gel electrophoresis
Cloning
Gene mapping
Genetically Modified Organisms
Gene Therapy
Thermophiles
RNA interference (RNAi)

MISCONCEPTIONS

- Fungal infections can be treated with antibiotics.
- Viruses can be treated with antibiotics.
- Microbes only have negative affects on other organisms.

- **Computation and Estimation**
  Science literacy includes being able to use computational tools thoughtfully and with confidence. The teaching of science should include problem solving that emerges from student activities and the content being studied. It requires students to make calculations and check their answers against their estimates and their knowledge of the problem.
- **Manipulation and Observation**
  Education for science literacy implies that students develop the habit of using tools to solve practical problems and to increase their understanding of how the world works. Tools, from hammers and notebooks to cameras and computers, extend human capabilities.
- **Communication**
  Discourse in science calls for the ability to communicate ideas and share information with fidelity and clarity, and to read and listen with understanding.
- **Critical Response Skills**
  In various forms, the mass media, teachers, and peers inundate students with assertions, arguments, and claims about all kinds of things. Science education should prepare people to read or listen to such assertions critically, deciding what evidence to pay attention to and what to dismiss. Furthermore, people should be able to apply those same critical skills to their own observations, arguments, and conclusions, thereby becoming less bound by their own prejudices and rationalizations. These critical response skills can be learned, and with practice, can become a lifelong habit of mind. Critical response skills include, but may not be limited to: questioning the reliability of data; questioning sources of information for validity and bias; making sure scientific methods are reliable, consistent and reproducible; recognizing multiple points of view; and recognizing that scientific understanding is a matter of interpretation.

APPLICATIONS OF LEARNING

- **Solving Problems** - Recognize and investigate problems; formulate and propose solutions supported by reason and evidence.

	• **Communicating** - Express and interpret information and ideas. • **Using Technology** - Use appropriate instruments, electronic equipment, computers and networks to access information, process ideas and communicate results. • **Working on Teams** - Learn and contribute productively as individuals and as members of groups. • **Making Connections** - Recognize and apply connections of important information and ideas within and among learning areas.

STAGE TWO: DETERMINE ACCEPTABLE EVIDENCE

FORMATIVE ASSESSMENTS	
Laboratories and Activities	**Journal/Reflections**
Lab/Activities Food Microbiology: Yogurt Lab Ice cream Lab Cheese Lab Root beer Lab Kimchee Lab Fermentation of Sugar by Yeast Medical Microbiology: Gene therapy activity Modes of action of antibiotics Environmental Microbiology: Oil Degradation Lab Methods of Food Preparation and Preservation Water Quality Lab Growth of fungus Biotechnology: Transformation Lab DNA hybridization Lab Separation of proteins via gel	Daily journal readings and reflections • How can eating foods containing bacteria benefit me? • Why don't (shouldn't) doctors prescribe antibiotics for every illness? • How do saprobes benefit the environment? • Describe two symbiotic relationships involving a microbe. • How has technology improved our quality of life? • How do ethical issues impact the way we manipulate microbes? • How do ethical issues impact the way we use technology?

Case studies FM CS #2: The Chemistry of Biology • The utility of some microbial products for industrial processes. • The role that microbes play in the cycling of carbon and other elements in the environment. • The resistance of some compounds to microbial degradation. FM CS #7: Elements of Microbial Nutrition, Ecology, and Growth • The importance of microbes in the environment. • The potential roles of microbes in bioremediation of contaminated sites. FM CS #8: An Introduction to Microbial Metabolism: The Chemical Crossroads of Life • The importance of normal microbial flora. • The bactericidal effect of certain microbial by-products of metabolism. FM CS #11: Physical and Chemical Agents for Microbial Control • The mode of action of various antimicrobial chemicals. • Factors that affect the germicidal activity of chemicals. FM CS #12: Drugs, Microbes, Host – The Elements of Chemotherapy • The concept of antimicrobial chemotherapy. • The characteristics of different types of antibiotics. FM CS #26: Environmental and Applied Microbiology • The goals of bioremediation. • Nutritional and environmental requirements of microorganisms used in environmental cleanup. • The requirements for successful biodegradation. • The role of microorganisms in ecosystems. FM CS #27: Applied and Industrial Microbiology • The limits of traditional microbiological techniques. • The use of genetic fingerprinting to characterize bacterial species.	

SUMMATIVE ASSESSMENTS	
Performance Tasks	**Other Evidence**
• Lab practical • Case study	• District common assessment

STAGE THREE: LEARNING PLAN

Food Microbiology

Explain and demonstrate how microbes are important in producing various products for human consumption.
Describe how fermentation aids in the production of food products.
Distinguish between food preparation techniques that are utilized to preserve food supplies.
Explain and discuss methods of controlling microbe populations.

Medical Microbiology

Describe how microbes are important in producing various products that are useful in everyday lives of humans, such as toothpastes.
Explain how products of microorganisms are used to create pharmaceuticals to treat illness.
Describe the mechanisms by which certain products work to treat illness.
Compare and contrast different chemotherapy agents.
Consider and debate issue in ethical use of biotechnological treatments.
Debate the use and requirement of vaccinations in the general public.

Environmental Equilibrium

Explain how microbes play a vital role in ecosystems and agriculture.
Describe how microbial ecology deals with the interaction between environment and microorganisms.
Compare and contrast living conditions for different microbes.
Explain the symbiotic relationships of microorganisms with other living organisms.
Explain how the soil supports a wide variety of microorganisms.
Explain how microorganisms are involved in processes such as decomposition, plant nutrition, and soil structure.
Describe how microbes are a part of the process of creating fossil fuels.
Describe how microbes are important in producing various products that are useful in everyday lives of humans, such as road paint.
Explain how microbes are used in treatment of sewage and producing potable water.
Predict how biotechnological techniques can aid in treatment of natural disasters, such as oil spills.

Bioengineering and Careers

Evaluate various biotechnological techniques and how they are used in food, industrial, medical, and/or environmental microbiology.
Examine careers in food, industrial, medical, and/or environmental microbiology.
Explain and debate ethical issues related to use of microorganisms.