

Microbiology & Biotechnology



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This compact but thorough supplement provides objectives and activities through which students can explore aspects of microbial diversity and modern biotechnology, including genetic engineering, cloning, and genome research.

Suitability:

- Grades 10-12
- Community College

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Biozone's unique formula encourages self direction, while dovetailing with traditional resources.

Chapters

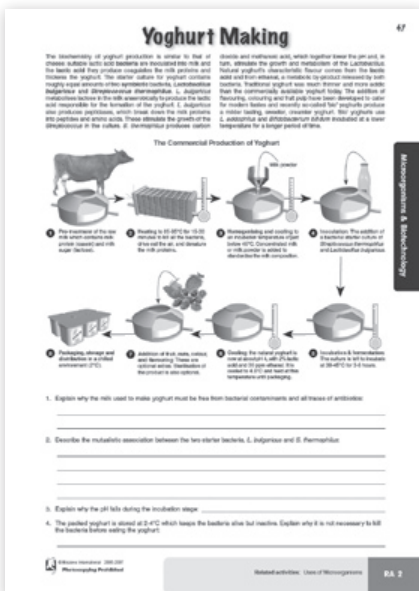
- Microorganisms & Biotechnology
- Cloning and Cell Culture
- Genetic Manipulation
- Biotechnology in Medicine
- Genome Research

Features

- **Introduction to the topic:**
A concise introduction to the concepts in the activity.
- **Easy to understand diagrams:**
Highly visual, clearly annotated diagrams improve the accessibility of information.
- **Consolidation and branching out:**
Activities provide information to consolidate basic knowledge, while allowing scope for exploring. Differential instruction becomes easier and students at all levels are encouraged to be 'thinkers'.
- **Write-on format:**
Activities provide information to consolidate basic knowledge, while allowing scope for exploring.
- **Tear-out pages:**
Each page has a perforation to allow easy removal for marking, or placement in a ring binder.
- **Activity Code:**
Each activity is coded to identify the skills required for its completion.

Yoghurt Making

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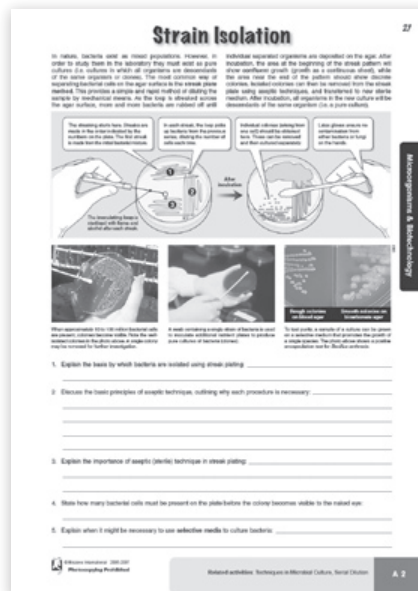


1. Explain why the milk used to make yoghurt must be free from bacterial contaminants and strains of antibiotic resistance.
2. Describe the metabolic association between the two starter bacteria, *L. bulgaricus* and *S. thermophilus*.
3. Explain why the pH falls during the incubation stage.
4. The packed yoghurt is stored at 2-4°C which keeps the bacteria alive but inactive. Explain why it is not necessary to kill the bacteria before eating the yoghurt.

Related activities: Uses of Microorganisms R.2

Strain Isolation

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1. Explain the basis by which bacteria are isolated using streak plating.
2. Discuss the basic principles of aseptic technique, outlining why such procedure is necessary.
3. Explain the importance of aseptic (sterile) technique in streak plating.
4. State how many bacterial cells must be present on the plate before the colony becomes visible to the naked eye.
5. Explain when it might be necessary to use selective media to culture bacteria.

Related activities: Techniques in Microbial Culture, Serial Dilution A.2

Drug Resistance in Pathogens

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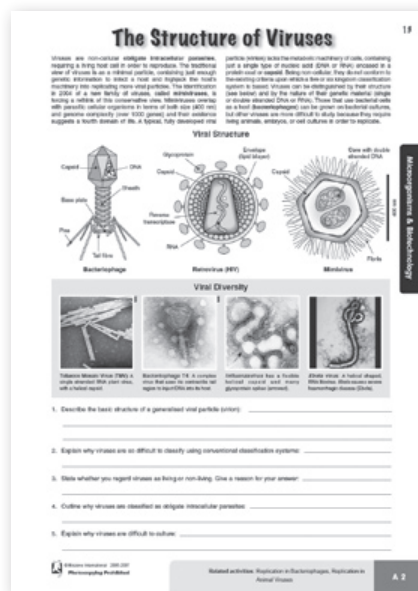


1. Describe how genes for drug resistance arise in a microbial population.
2. Describe two mechanisms by which bacteria acquire drug resistance.
3. Explain how health authorities could target multiple drug resistance in common pathogens.

Related activities: Antimicrobial Drugs R.2

The Structure of Viruses

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1. Describe the basic structure of a generalized (wild) phage particle.
2. Explain why viruses are so difficult to classify using conventional classification systems.
3. State whether you regard viruses as living or non-living. Give a reason for your answer.
4. Outline why viruses are classified as obligate intracellular parasites.
5. Explain why viruses are difficult to culture.

Related activities: Replication in Bacteriophages, Replication in Animal Viruses A.2

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Content Overview

MICROORGANISMS & BIOTECHNOLOGY

- Microbial Groups
- Features of Microbial Groups
- The Structure of Viruses
- Replication in Bacteriophages
- Replication in Animal Viruses
- Bacterial Cells
- Growth in Bacterial Populations
- Review of Bacterial Structure
- Antimicrobial Drugs
- Drug Resistance in Pathogens
- Fungi
- Techniques in Microbial Culture
- Strain Isolation
- Serial Dilution
- Uses of Microorganisms
- Energy Resources
- Sewage Treatment
- Industrial Microbiology
- Industrial Production of Enzymes
- Putting Enzymes to Work
- Applications of Enzymes
- White Wine Production
- Red Wine Production
- Beer Brewing
- Bread Making
- Cheese Making
- Yoghurt Making
- Soy Sauce Production

CLONING AND CELL CULTURE

- Cloning by Embryo Splitting
- Cloning by Nuclear Transfer
- Plant Tissue Culture
- Stem Cells and Tissue Engineering
- The Human Cloning Debate

GENETIC MANIPULATION

- The Nature of GMOs
- Restriction Enzymes
- Ligation
- Gel Electrophoresis
- Polymerase Chain Reaction
- Gene Cloning Using Plasmids
- Transgenic Organisms
- Genetically Modified Plants
- Using Recombinant Bacteria
- The Ethics of GMO Technology

BIOTECHNOLOGY IN MEDICINE

- Production of Human Proteins
- Monoclonal Antibodies
- Types of Vaccines
- Edible Vaccines
- Gene Therapy
- Gene Delivery Systems
- Vectors for Gene Therapy

GENOME RESEARCH

- Manual DNA Sequencing
- Automated DNA Sequencing
- Genome Analysis
- DNA Profiling Using PCR
- DNA Profiling Using Probes
- DNA Chips
- Investigating Genetic Biodiversity
- The Human Genome Project
- Genome Projects

APPENDIX: Biotechnology Review

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Ligation

DNA fragments produced using restriction enzymes may be reassembled in a process called ligation. Plasmids are joined together using an enzyme called DNA ligase. DNA of different origins produced in this way is called recombinant DNA.

Creating a Recombinant DNA Plasmid

- If two pieces of DNA are cut by the same restriction enzymes, they will produce fragments with matching sticky ends. Sticky ends will rejoin to form a circular plasmid.
- Other two such matching sticky ends come together, they can join by cross-joining. This process is called annealing. This is when DNA fragments from a different source (perhaps a plasmid) are joined to the DNA fragment.
- The joined fragments will usually form either a linear molecule or a circular one, as shown here for a plasmid. However, other combinations of fragments can occur.
- The fragments of DNA are joined together by the enzyme DNA ligase, producing a molecule of recombinant DNA.

NOTE: The order of the sticky ends of the larger DNA fragment is important.

NOTE: The order of the sticky ends of the larger DNA fragment is important.

1. Explain in your own words the two main steps in the process of joining two DNA fragments together:
 (a) Annealing: _____
 (b) DNA ligase: _____

2. Briefly state the usual role of DNA ligase in a cell (don't refer to a reference on DNA replication).

3. Explain why ligation can be considered the reverse of the restriction enzyme process.

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Investigating Genetic Biodiversity

PCR and DNA sequencing can be used in the assessment of genetic biodiversity. From a comparative point of view, large amounts of genetic variation within a species may be indicative of a greater ability to adapt to environmental change (e.g. changes in climate). The amount of variation between populations of a species is of particular interest. Sometimes the genetic variation found between populations is enough to warrant separating them into two or more morphologically distinct species. Sometimes populations that are geographically separated, but different genetically, are classified as different species. This is often the case with plants and animals. One particular species, *Coniostegia hirsuta*, is the largest sea urchin ever recorded in the Antarctic continent. It is being studied in an area of Antarctica known as the Dry Valleys, particularly in Taylor Valley. This region is largely ice-free, and the springtime winds that sweep through the region are thought to have blown in genetic material from other DNA sources. This may indicate the presence of more than one species. An climate change and the presence of humans affect the habitat of Taylor Valley over time. It is important to understand and monitor the genetic variation of the sea urchin populations in order to ensure that biodiversity is conserved.

The molecular diversity of a species is assessed in a small amount of DNA over 1 cm long. Scientists investigated the genetic differences between populations of an Antarctic sea urchin in the process.

Taylor Valley, one of the Dry Valleys in Antarctica, is one of the most extreme environments on Earth.

The Process of DNA Analysis of Two Springtails (A and B) is Illustrated below:

- Extraction of DNA: Proteinase enzymes break down the tissues of the springtail to release DNA.
- PCR Mix: PCR Mix contains the DNA template, primers, dNTPs, Taq polymerase, and Mg²⁺.
- PCR: DNA amplification at 94°C, 60°C, 72°C.
- Gel Electrophoresis: Gel Electrophoresis separates the DNA products by size.
- Sequencing of PCR product: Sequencing of PCR product.

© 2008 Pearson Education. All rights reserved. **Related activities:** Gel Electrophoresis, Polymerase Chain Reaction, DNA Sequencing **RA 3**



USA & Canada
 Biozone International Ltd
 P.O. Box 13-034, Hamilton 3251,
 New Zealand
Toll Free: 1 866 556 2710
Free Fax: 1 800 717 8751
 Email: sales@biozone.co.nz
 www.thebiozone.com

UK & Europe
 Biozone Learning Media (UK) Ltd
 Bretby Business Park, Ashby Road,
 Bretby, Burton upon Trent, DE15 0YZ, UK
 Phone: +44 1283 553 257
 Fax: +44 1283 553 258
 Email: sales@biozone.co.uk
 www.biozone.co.uk

Australia
 Biozone Learning Media Australia
 P.O. Box 2841, Burleigh BC, QLD 4220,
 Australia
 Phone: +61 7 5535 4896
 Fax: +61 7 5508 2432
 Email: sales@biozone.com.au
 www.biozone.com.au

Rest of the World
 Biozone International Ltd
 P.O. Box 13-034, Hamilton 3251,
 New Zealand
 Phone: +64 7 856 8104
 Fax: +64 7 856 9243
 Email: sales@biozone.co.nz
 www.biozone.co.nz