Unit title: Industrial Microbiology

Unit code: **J/601/0235**

QCF level: **5**

Credit value: **15**

Aim

This unit develops learners' understanding of the legislation and use of micro-organisms in industrial and commercial applications. The techniques needed to prevent and detect microbial contamination are also examined.

Unit abstract

Micro-organisms have been used to produce certain food products and beverages since ancient times but today they are grown on a large scale to produce valuable commercial products or to carry out chemical reactions.

In this unit learners will undertake practical investigations to study microbial growth, growth cycles and the factors which affect population growth and the yield of products. Learners will need to understand how growth conditions can be manipulated to influence the end product and the role of genetic engineering in industrial microbiology.

Biotechnology has had a major impact on modern food production, and the production of insulin, growth hormones and blood clotting factors. Through this unit learners will also develop their knowledge of current legislation relevant to industrial microbiology.

In addition, learners will gain an understanding of the physical and chemical methods used to control microbial contamination and how to undertake quality control measures.

Learning outcomes

On successful completion of this unit a learner will:

1 Be able to investigate microbial growth

2 Understand the commercial and industrial applications of micro-organisms

3 Understand the methods available for the control of microbial contamination

4 Be able to detect microbial contaminants and undertake quality control procedures

5 Understand current legislation relating to industrial microbiology.

Unit content

1 **Be able to investigate microbial growth**

Practical investigations: examples of small-scale production of micro-organisms; dilution plating; direct count (haemocytometer); death phase

Growth cycles: batch and continuous fermentation; lag, log; stationary; death phase

Growth characteristics: factors affecting population growth and yield of product

Limits to growth: factors limiting growth and the problems of large-scale production

2 **Understand the commercial and industrial applications of micro-organisms**

Fermentation processes: brewing, beer, wine; lactic fermentations; production of antibiotics, hormones, amino acids, enzymes, citric acid; microbes as food

Biotechnology: recombinant DNA techniques; genetically modified organisms; production of insulin growth hormone; blood clotting factors

Bioreactors: batch and continuous processes; contamination control; growth parameters; process control mechanisms; sampling techniques and parameters; product control and monitoring

Water management: sewage/effluent treatment and disposal; purification of drinking water; surveillance of water supplies; high/low temperature treatments; irradiation; filtration; removal of available water; disinfectants

3 **Understand the methods available for the control of microbial contamination**

Physical and chemical methods of contamination control: reduction of viable population against time; heat treatments, pasteurisation, sterilisation; irradiation; filtration; disinfection

Chemicals used: types eg germicide/biocide, antisepses, disinfectants, sterilising agents; limitations

4 **Be able to detect microbial contaminants and undertake quality control procedures**

Standard methods of detection and identification of microbial contaminants: skin flora eg staphylococcus; gut flora eg E coli; mycoplasma; cryptosporidium in water supplies; organisms in air and dust eg micrococcus; moulds and yeasts

Rapid methods: detection and identification eg use of luciferase, RNA activity

Hazard analysis: Hazard Analysis Critical Control Point (HACCP)

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5 **Understand current legislation relating to industrial microbiology**

Statutes which are relevant to industrial microbiology: EU Drinking Water Directive 98/83/EC; Nitrates Directive 91/676/EEC; Urban Waste Water Treatment Directive 98/15/EEC; Genetic Manipulation Regulations 1989; Genetically Modified Organisms (contained use) Regulations 1992; European Patent Convention 1978

Biotechnology industry: types eg agri-food, pharmaceutical, medical, environmental

Learning outcomes and assessment criteria

Learning outcomes On successful completion of this unit a learner will:		Assessment criteria for pass The learner can:	
LO1	Be able to investigate microbial growth	1.1	carry out practical investigations in order to obtain data on microbial growth, using safe practices
		1.2	construct graphs that provide information and data on microbial growth cycles and characteristics
		1.3	interpret the experimental growth data relating to growth cycles and characteristics
		1.4	explain the limits of growth in large-scale production of micro-organisms
LO2	Understand the commercial and industrial applications of micro-organisms	2.1	review commercially important products from microbial fermentation processes
		2.2	review the species commonly used in the fermentation processes for the production of products
		2.3	discuss the principles of biotechnology that underpin the manufacture of products
		2.4	discuss the use of bioreactors in manufacturing
		2.5	analyse the routine practices underlying water management in terms of sewage treatment and water purification
LO3	Understand the methods available for the control of microbial contamination	3.1	assess the effectiveness of physical and chemical methods of reducing microbial growth
		3.2	assess the effectiveness of the types of chemicals used
LO4	Be able to detect microbial contaminants and undertake quality control procedures	4.1	carry out selectively and safely, standard and rapid methods of detection and identification of microbial contaminants
		4.2	create a scheme of hazard analysis for two commercial applications of micro-organism
LO5	Understand current legislation relating to industrial microbiology	5.1	discuss the statutes which are relevant to industrial microbiology and their impact.

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Guidance

Links

This unit has particular links with the following units within this qualification:

- *Unit reference number T/601/0215: Cell Biology*
- *Unit reference number F/601/0301: Quality Assurance and Quality Control*
- *Unit reference number L/601/0219: Laboratory Techniques for Applied Biology*

Essential requirements

Delivery

Delivery of learning outcome 1 must include learners participating in practical activities concerned with investigating growth cycles and characteristics of micro-organisms and limitations in relation to large-scale production. Tutors must emphasise the importance of health and safety.

For learning outcome 2, appreciation of the commercial and industrial application of micro-organisms must involve a detailed review of the fermentation processes used in a range of sectors including water management. This must include a detailed examination of the principles of biotechnology that underpin each process.

For learning outcome 3, there must be a detailed assessment of the physical and chemical methods used to control microbial contamination and any associated limitations.

Practical activities form the focus of learning outcome 4, where learners need to experience standard and rapid methods for the detection and identification of microbial contaminants.

For learning outcome 5, learners must discuss the main points of current British and European legislation that are relevant to microbiology and give examples of how certain statutes can influence biotechnological activities across a range of industrial sectors.

Assessment

For learning outcomes 1 and 3, learners must understand the growth of micro-organisms and the control methods available. Evidence may be generated through a combination of experimental work and written reports including graphical representations of data for learning outcome 1, and answering appropriate questions.

Learning outcome 2 involves investigation of the commercial and industrial applications of micro-organisms. Evidence should be supported by laboratory exercises, for example the culture of yoghurt or a small-scale fermentation. The standard methods for enumeration of important organisms in drinking water should be performed in the laboratory, the results reported and their significance discussed.

Learning outcome 4 involves practical work to familiarise learners with the range of techniques available for the culture, identification and quality control of micro-organisms. The choice of techniques will depend on the facilities and equipment available, but learners must be introduced to a range of rapid identification kits.

Learning outcome 5 involves learners becoming familiar with relevant legislation. The content to be covered is likely to change over time and the importance of keeping up-to-date with developments must be stressed.

Resources

Learners require access to a microbiology laboratory and a range of different micro-organisms. Appropriate technical support is also required. The range of practical techniques undertaken must include some growth-dependent methods and rapid diagnostic assays or kits.

Employer engagement and vocational contexts

Learners will benefit from visits to industrial and commercial establishments that are engaged in microbiological activities. For example breweries, water treatment works and food manufacturing plants.

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