

Edexcel Biology B3

Topic 1 — Biotechnology

Biotechnology is one of the fastest growing new industries in the developed world.

The biotechnology industry will need highly-skilled people to work in it. This unit gives students the opportunity to study the contribution of biotechnology in the production of food and drink, and how this could impact on world food shortages, the treatment of disease and development of new medicines.

As with all new developments, advances in biotechnology raises new ethical questions which will be considered in this topic.

Questions

- Will scientists be able to make me a personalised medicine?
- Who owns the medicine if the original plants come from a different country?
- Are we able to cure genetic diseases?
- Should you be allowed to choose the sex of your baby?
- Is genetically modified food safe to eat?
- Do genetically modified organisms harm the environment?
- Can't we already feed the world?
- Should we be making developing countries buy new seeds every year?

Know

- The food industry has traditionally made much use of biotechnology in the production of many food items, for example cheese, yoghurt, alcohol, chocolate, soy sauce and, more recently, mycoproteins and prebiotics.
- Plants can be modified to be resistant to herbicides and/or pests and this has environmental implications.
- The pharmaceutical industry generates a lot of money annually and consideration of the contributors to this profit and its distribution is needed.
- Stem cell research must consider many ethical questions, including the definition of 'life'.
- Organisms can be genetically modified to produce substances, including medicines that are of direct use to human health.

Glossary

You will be expected to be able to recall, explain, describe and use appropriately the following words and phrases:

amino acid, ethics, herbicide, pasteurization, artemisinin, fermentation, insulin, prebiotics, bacteria, filtration, invertase, quinine, biotechnology, gelling agent, lactic acid, resistance, breeding, gene, lactose, salicin, cholesterol, genetic engineering, malaria, stem cells, chymosin, genetic modification, microorganism, taxol, citric acid, genome, obesity, toxin, enzyme, genomics, oligosaccharide, vector, ester, glutamic acid, Parkinson's disease, yeast

Know how to:

- distinguish between and use primary and/or secondary data
- discuss and evaluate evidence and data
- consider ethical, contemporary and social issues.

Food and drink

- bacteria are used in the production of yoghurt from milk by the conversion of lactose to lactic acid
- the commercial production of soy sauce includes fermentation of a mixture of cooked soya beans and roasted wheat using *Aspergillus*, further fermentation using yeasts and then *Lactobacillus*, filtration, pasteurisation, sterile bottling
- functional foods are not necessarily produced by fermentation, including prebiotics such as oligosaccharides found as a food ingredient on the supermarket shelf, and ‘spreads’ that contain plant stanol esters that lower cholesterol
- prebiotics are functional foods that are marketed as providing health benefits
- microbial products are used in food, including:
 - vitamin C produced by *Acetobacter* spp. (bacterium)
 - carrageen, a gelling agent from seaweed
 - enzymes such as invertase (sucrase) produced by *Saccharomyces cerevisiae* (yeast) used in the manufacture of sweets
 - citric acid produced by *Aspergillus niger* (fungus) used in fizzy drinks
 - amino acids such as glutamic acid produced by *Corynebacterium glutamicum* (bacterium) and the flavour enhancer, monosodium glutamate (MSG), a sodium salt of glutamic acid
- the production of the enzyme chymosin, produced by genetically altered microorganisms, which is used in the manufacture of vegetarian cheese
- the importance of having a well-balanced diet, in terms of a healthy lifestyle
- the possible consequences of being severely overweight or underweight for your height
- the potential of biotechnology and evaluate in relation to world food shortage, eg kwashiorkor.

Plant modification

- weed control to reduce loss of food supplies by genetically modifying crops to ensure they are resistant to herbicides
- the use of *Agrobacterium tumefaciens* as a vector to transfer genes coding for herbicide resistance to the genome of a plant cell
- breeding insect-resistant plants including the insertion of the toxin gene from *Bacillus thuringiensis* and inserting it into plants
- the ethics of genetic modification and its use, for example, plants and animals in developing countries.

Reproduction

- stem cell research and therapies as possible treatments for diseases such as Parkinson’s disease
- allowing people to choose the sex of their baby may skew the sex balance of the population and may lead to other choices being permitted – including colour of eyes
- ethical implications of reproductive biology research.

Pharmaceuticals

- the importance and medicinal value of drugs produced by plants, including:
 - aspirin – compound called salicin found in the bark and leaves of willow plants used for pain-relief
 - taxol – derived from the bark of the Pacific yew tree and used as an anti-cancer agent
 - quinine which comes from the bark of the cinchona tree: until the 1930s it was the only real treatment for malaria
 - artemisinin and its derivatives – extracted from the Chinese plant *Artemisia annua* used for treating malaria and reducing its transmission

- consider the advantages and disadvantages of drugs derived from plant sources compared to synthetic drugs
- an awareness of the potential for discovering sources of new drugs, including rainforests
- the production of insulin using genetic engineering: an understanding of the role of recombinant DNA technology including restriction enzyme, ligase and sticky ends
- the role of biotechnology in developing new substances, for example, the use of genomics in medical research to develop personalised medicines.

Topic 2 – Behaviour in Humans and Other Animals

Behaviour is an essential part of any animal's strategy for survival. This unit gives students an insight into instinctive and learned behaviour and how humans may make use of conditioning when training animals. The topic compares feeding behaviour in herbivores and carnivores and considers parental care as part of reproductive behaviour. It also explores the ethical issues surrounding the use of animals by humans.

Questions

- Why do dogs greet each other by sniffing?
- Why do fish shoal?
- What instincts are you born with and what do you learn?
- How can people 'read' your face?
- Why do cows spend all day eating?
- Why are dogs so different from cats?
- How does sexual attraction work in humans?
- Do animals have rights?

Know:

- Animals have evolved instinctive behaviours, through natural selection, which increase their chances of survival.
- Animals learn throughout their lives to increase their chances of survival and reproduction.
- Feeding behaviours maximise animals' chances of finding sufficient food.
- Reproductive behaviours maximise animals' chances of successfully passing on their genes.
- Social behaviours and communication skills enable animals to respond in particular ways to members of their own species and to members of other species.
- Humans have made use of other animals in different ways, and there is an increasing awareness of animal welfare issues that need to take account of animal behaviour.

Glossary

You will be expected to be able to recall, explain, describe and use appropriately the following words and phrases:

Anthropomorphism, emotion, inherit, protection, behaviour, evolution, instinctive, selection, Bird, experience, learning, sexual reproduction, carnivore, facial expression, mammal, signal, Communicate, gesture, pack, sound, conditioning, great ape, pheromones, vertebrate, Conscious, habituation, posture, courting, herbivore, predation

Know how to:

- distinguish between and use primary and/or secondary data
- discuss and evaluate evidence and data
- consider the ethical, contemporary and social issues.

Instinctive and learned behaviour

- animals inherit certain patterns of behaviour from their parents known as instinctive behaviour
- an animal's early experiences in life have a big impact on the way in which it behaves as an adult
- habituation is an important part of the learning process in young animals
- animals can learn through conditioning
- humans can make use of conditioning when training captive animals for specific purposes.

Social behaviour and communication

- much behaviour requires animals to communicate
- communication happens in different ways, eg, sounds, signals, and chemicals (pheromones)
- most mammals are able to communicate their intentions through body posture and facial expression
- facial expressions are species-specific; a gesture or expression may appear as a threat to one species, but may mean something totally different to another
- humans have developed highly-complex ways of communicating – transmitting knowledge of past events, emotions, and complex ideas to other humans
- humans are conscious of the outcomes of their actions, and as a result are more self-aware than other animals.

Feeding behaviours

- feeding behaviours are different depending on the type of food being consumed
- herbivores have to eat more food in order to get the nutrients (particularly amino acids) they require so that more time is spent eating
- vertebrate herbivores may feed in large groups or herds, and they may do so for protection in numbers. This is a successful evolutionary strategy, even though some members of the herd may be killed.
- vertebrate herbivores who feed in large groups usually need to be continually on the move to find new feeding areas
- herbivores have to be good at avoiding, fleeing from, or resisting predation
- carnivores eat protein-rich food and have to spend less time actually eating
- carnivores have to be good at detecting and catching their food
- some carnivores hunt efficiently in packs
- some carnivores hunt efficiently as individuals
- mammals and birds have special feeding behaviours in relation to their young, since they show parental care
- some animals have developed the use of tools in their search for food.

Reproductive behaviours

- sexual reproduction requires finding and selecting a suitable mate; it can involve courting behaviour
- some animals mate for life, others select several different mates during the mating season
- some animals, in particular birds and mammals, have developed special behaviours for the rearing of young, since they display parental care
- parental care is a successful evolutionary strategy; although it involves risk to the parents, it can increase the chances of survival of the parental genes.

Human behaviour in relation to other animals

- humans are one of the great apes, and have developed from small family groups of hunter-gatherers, closely related to bonobos (pygmy chimpanzees), to complex societies capable of gross modification of their own environment

- humans have exploited other animals; originally hunters, they domesticated animals that helped them hunt; as humans developed agriculture, humans exploited herd animals to provide a constant and dependable source of food
- humans have exploited animals in other ways, as a source of clothing and domestic materials and, more recently, for medical purposes
- humans also use animals as a source of entertainment (hunting, racing, circuses, wildlife parks) and companionship (pets)
- we debate the ethics of the use of animals in these different ways; some consider that animals have rights comparable or identical to humans, others consider that such beliefs untenable.
- It is a mistake to interpret behaviour observed in other animals as showing human characteristics (anthropomorphism) and it is also a mistake to assume that human and animal behaviours have nothing in common.