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Visions of the Future: Part II

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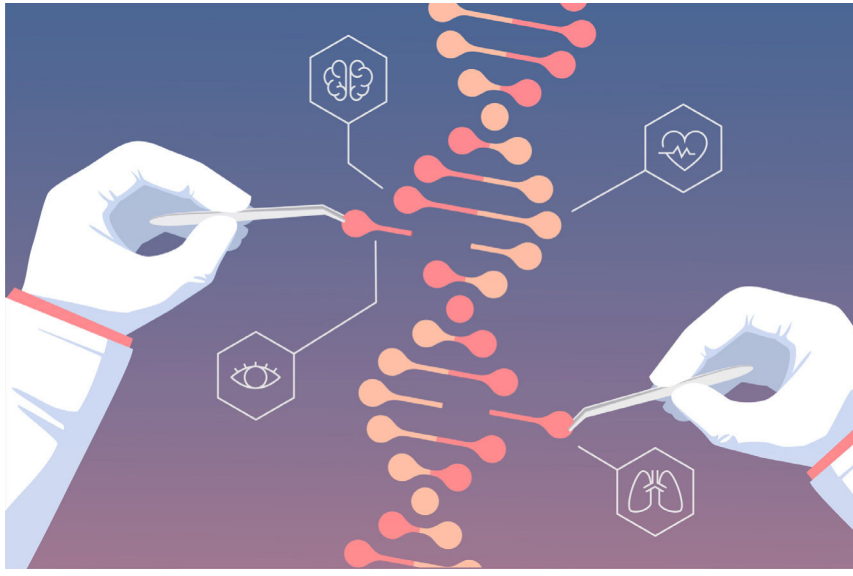
Visions of the future – Part II: Biotechnology

by Rainer Jacob



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Biotechnologie – Verheißung oder Fluch? Können wir damit eine bessere Zukunft schaffen, den Hunger in der Welt besiegen, unheilbare Krankheiten heilen, Gendefekte reparieren? Dürfen wir den Zufall in der Evolution ausschalten, Gene verändern, die Charaktereigenschaften und äußere Erscheinung von Embryonen im Labor vorherbestimmen, Designerbabys und perfekte Übermenschen erschaffen und das Leben verlängern? Diese und weitere Fragen stellen sich angesichts der aktuellen Fortschritte in Biotechnologie, Gentechnik und Gentherapie. Die Lernenden erfahren und diskutieren Anwendungsmöglichkeiten, Errungenschaften und künftige Entwicklungen der Biotechnologie und Gentechnik in Industrie, Landwirtschaft und Medizin. Zudem erkennen sie Grenzbereiche und setzen sich mit damit verbunden ethischen Fragen auseinander.

RAABE KLASSE SCHULE

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by Rainer Jacob

Competences and skills:

In this unit students gain knowledge on scientific and ethical aspects of biotechnology. They enhance their **vocabulary** and strengthen their **reading skills** as they work with several texts. Students demonstrate their **viewing** and **listening skills** when engaging themselves with videos and movies. By completing research tasks, they acquire additional **media competences**.

Overview:

List of abbreviations:

A Analysis
C Comment
CT Creative Task
D Discussion / debate
G Group work
L Language
LVC Listening / viewing comprehension
M Mind map / visualising
P Working with a picture / cartoon
PR Presentation
R Research
RC Reading comprehension
S Summary
T Working with a text
VI Working with a video
W Writing

Topic	Material	Methods/Skills
1: Biotechnology – introduction	M1–M2	C, M, R, RC
2: Genetic engineering	M3	L, LVC, R, VI, W
3: Gene therapy in real life	M4–M5	A, L, LVC, R, RC, T, VI
4: Gene editing	M6–M9	C, D, G, L, P, RC, T, W
5: Human cloning in literature and film	M10–M14	A, C, CT, D, G, PR, RC, S, T, VI, W

Visions of the future – Part II: Biotechnology

Facts

Biotechnology is an exciting, stimulating but also intimidating or controversial field of scientific research. In laboratories around the globe, biotechnicians are trying to find out how we might make use of microorganism in industry and agriculture and apply genetic engineering techniques in medicine to advance human well-being, overcome diseases or avoid health problems. Since Scottish scientists produced a cloned sheep in 1997, genetic engineering has made enormous progress. The latest boost was the discovery of the genetic scissors called CRISPR, for which two women, Emmanuelle Charpentier and Jennifer Doudna, were awarded the Nobel prize in chemistry in 2020. With CRISPR, generic engineers can edit the DNA of plants, microorganisms and animals with extremely high precision. However, the advances made in genetic technologies also raise concerns about unforeseeable consequences for individuals and society.

Notes on the material

The material presented is divided into five topics, each of which presents a certain aspect of biotechnology. **Topic 1** introduces students to the subject, presenting the different application areas and colour codes used in biotechnology (sea resources, food production, industry, agriculture and medicine), as well as an assignment to research the internet for the history and present status of this field of science. **Topic 2** presents a video which explains in detail how gene therapy, an innovative use of genetic engineering, works. The video clarifies terms such as DNA, enzymes, genetic material, mutations and the role gene therapy can play in treating hereditary and rare diseases. An activity assignment asks students to collect practical information concerning gene therapy such as what kinds of illnesses can be treated with this method and who covers the costs. **Topic 3** focuses on Gene therapy and how it can help people who are impaired by poor eyesight. To introduce the subject of blindness, a young man explains in a video

what it means to be blind in everyday life. A report about a first-time operation on a patient suffering from dry macular degeneration (AMD) illustrates the application of gene therapy. Two assignments for further activity (internet research and mediation) ask students to research the life of the deafblind American author and political activist Helen Keller and the blind German Paralympic biathlete Verena Bentele. **Topic 4** deals with the controversial field of gene editing, the possibilities, dangers and ethical implications of the genomics revolution. Work on a cartoon about designer babies exemplifies the misuse of the technology for commercial purposes. A report on a scandal involving scientists who edited the genes of babies throws light on another aspect of a possibly problematic future of medicine. **Topic 5** completes the unit, making students familiar with visions, predictions and concerns of writers and filmmakers about genetic engineering and human cloning. The material provided can be used to discuss political and social issues connected with this area. An excerpt from Mary Shelley's classic Gothic novel *Frankenstein* shows students that already in the early 19th century, the novelist raised the issue of scientific ethics. The questions "How far can scientists go? Where are the limits of scientific research? Is technology ahead of ethics?" are still relevant today. At the beginning of the 20th century, Aldous Huxley warned about the political consequences if gene techniques fall into the hands of a totalitarian regime, thus emphasising the urgency to introduce regulations on genetic engineering. Students learn that this is still a relevant and widely discussed problem today. To conclude the unit on biotechnology, students work in groups on a number of novels and films depicting future uses and abuses of genetic engineering. The groups are asked to design a poster which contains general information on the chosen work, its contents and themes and present it to the class. In this way, the unit makes students realise how far modern biotechnology has progressed from Darwin's original concept of random mutation to a process that is far more self-guided than anything Darwin could have imagined.

Topic 1: Biotechnology – introduction

M1 The application areas of biotechnology

One of the most advanced disciplines of scientific research today is biotechnology, the branch of molecular biology that studies the use of living organisms (especially microorganisms). A colour code system is being used to distinguish the various fields in which biotech is applied. For example, blue refers to biotechnology in the exploitation of sea resources, yellow in food production. The most promising and at the same time often controversial application areas are medicine (red like blood), agriculture (green like plants) and – less well-known – in industry (white).

White biotechnology: Industry

White biotechnology, also known as industrial biotechnology, refers to the application of the technique in industrial processes. Living cells from yeast[1], moulds[2], bacteria, plants and enzymes are used to produce useful and safe chemicals, for example for the manufacture of biodegradable[3] plastics or clothes from plants (a T-shirt from corn sugar). White biotechnology can help to replace polluting technologies, save energy and reduce waste in production processes.

Green biotechnology: Agriculture

Agriculture profits greatly from the use of genetic engineering techniques to increase food production and secure food supply. A procedure referred to as "genome[4] editing" modifies the genes of plants and makes them more resistant to pests, diseases and the vagaries[5] of climate change. In traditional farming, weeds, diseases or insect pests damage crops and cause devastating agricultural losses which cause hunger and malnutrition in fragile developing economies. In addition, agricultural biotechnology can also help to enrich plants with nutrients so that crops contain more iron, vitamin A and protein and can make up for vitamin deficiencies and raise health standards in many regions.

Due to the obvious advantages of genetically modified crops, agriculture in the United States relies to a great extent on the cultivation of engineered soybean, cotton or corn. In American supermarkets, the range of GM foods – including pizza, chips, cookies, ice cream, salad dressing, corn syrup, and baking powder – is on a steady increase. In contrast to American consumers, Europeans have reservation against food containing ingredients from modified plants. Genetically

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