



Mark Scheme (Results)

June 2019

Pearson BTEC Level 3 National
Extended Diploma– Applied Science

Unit 7: Contemporary Issues in Science



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Unit 7: Contemporary Issues in Science - Sample marking grid

General Marking Guidance

- All learners must receive the same treatment. Examiners must mark the first learner in exactly the same way as they mark the last.
- Marking grids should be applied positively. Learners must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the marking grid not according to their perception of where the grade boundaries may lie.
- All marks on the marking grid should be used appropriately.
- All the marks on the marking grid are designed to be awarded. Examiners should always award full marks if deserved. Examiners should also be prepared to award zero marks if the learner's response is not rewardable according to the marking grid.
- Where judgment is required, a marking grid will provide the principles by which marks will be awarded.
- When examiners are in doubt regarding the application of the marking grid to a learner's response, a senior examiner should be consulted.

Specific Marking guidance

The marking grids have been designed to assess learner work holistically.

Rows within the grids identify the assessment focus/outcome being targeted. When using a marking grid, the 'best fit' approach should be used.

- Examiners should first make a holistic judgement on which band most closely matches the learner response and place it within that band. Learners will be placed in the band that best describes their answer.
- The mark awarded within the band will be decided based on the quality of the answer in response to the assessment focus/outcome and will be modified according to how securely all bullet points are displayed at that band.
- Marks will be awarded towards the top or bottom of that band depending on how they have evidenced each of the descriptor bullet points.

Question 1: *Discuss the implications of the scientific issue identified in the articles. (12 marks)*

Assessment focus	Band 0	Band 1	Band 2	Band 3	Band 4
Understanding the impact in terms of ethical/social/economical/environmental	0	1-3	4-6	7-9	10-12
	Level of response not worthy of credit	<p>Demonstrates limited knowledge and understanding of the scientific issues with generalised comments made.</p> <p>No or limited attempt to draw links to ethical/social/economic/environmental implications.</p> <p>The discussion will be unstructured and limited to basic points made.</p>	<p>Demonstrates adequate knowledge and understanding of the scientific issues by identifying and selecting relevant implications from all three articles.</p> <p>Attempts to draw links to ethical/social/economic/environmental implications.</p> <p>The discussion shows some structure and coherence.</p>	<p>Demonstrates good knowledge and understanding of the scientific issues by identifying and selecting relevant implications from all three articles.</p> <p>Draws some links to and between ethical/social/economic/environmental implications.</p> <p>The discussion shows a structure that is mostly clear, coherent and logical.</p>	<p>Demonstrates comprehensive knowledge and understanding of the scientific issues by identifying and selecting relevant implications from all three articles.</p> <p>Draws a wide range of links to and between ethical/social/economic/environmental implications</p> <p>The discussion shows a well-developed structure that is clear, coherent and logical.</p>

Possible indicative content for Question 1:

Learners:

- **May include other valid suggestions, not listed below, which should be credited.**
- **May cover a number of examples from the list below.**
- **Would NOT be expected to cover all points to get full marks.**
- **Will not necessarily specify whether the points they are making are economic/social/environmental/ethical.**

Scientific issue

- Genetically modified (GM) crops are crops that are bred for enhanced properties such as improved growth, disease or weather resistance, longer shelf life, nutritional enhancement etc.
- GM crops could be part of the solution to global food security issues (particularly in undeveloped, poorer countries).
- GM crops are seen as controversial; supported by many scientists, philanthropists and some continents (e.g. USA and Asia), but opposed by activist groups such as Greenpeace and Friends of the Earth, and the European Union.

- CRISPR-Cas9 is a technology that allows crops to be genetically edited by inserting or removing genetic code from different sources into their DNA.
- Golden Rice is a form of rice that has been genetically modified to contain high levels of Vitamin A by introducing genes from daffodils or maize that allow synthesis of beta carotene (the precursor of Vitamin A).
- Vitamin A deficiency causes blindness in children and is a serious health concern in the developing world. It also causes death in children due to reduced resistance to infections.
- Rice is a staple produce in many poor and undeveloped countries and Golden Rice could offer a solution to this problem in countries where rice is the staple food, as it does not cost any more than white rice.

Comment	Implication	Factor
The research, development and use of genetically modified organisms (GMOs) in food production	Crops that are genetically modified (GM) can have enhanced properties such as improved growth, disease or weather resistance, longer shelf life, etc. (Articles 1, 2 and 3)	Economic Environmental
	Golden Rice is a form of rice that has been genetically modified by introducing genes from daffodils or maize that allow synthesis of beta-carotene, (a pro-vitamin) which humans can then convert to Vitamin A, and could be genetically engineered/edited to tackle other micronutrient deficiencies in humans. (Articles 2 and 3)	Social Ethical
	GM crops offer a more efficient way of farming for populations that are reliant on GM crops to grow their own food. (Article 3)	Social Economic Environmental
	CRISPR-cas9 is a technology that allows crops to be genetically edited by removing genetic code or inserting it from different sources into their DNA (Article 1), but there could be unintentional consequences no-one has foreseen. (Article 1 and 2)	Ethical Social Economic Environmental
	Golden Rice field trials in the Philippines were destroyed by activists. (Article 3)	Ethical Social Environmental
	Golden Rice food trial using Chinese children as "guinea pigs". (Article 3) – use of emotive language	
GM crops, such as Golden Rice, could be a solution to food security, poverty and world health	<p>Industrialised countries can import food but food production in non-industrialised countries is under-resourced and these countries are reliant on growing their food. (Article 3)</p> <p>GM crops could be part of a solution to global food security issues particularly in undeveloped, poorer countries. (Article 1 and 3)</p> <p>Golden Rice could be used to reduce Vitamin A deficiency, which causes blindness and child death,</p>	Ethical Social Economic Environmental

	<p>due to lack of resistance to infection, (Article 3) but could detract from other methods of tackling vitamin A deficiency that could be as effective. (Article 2)</p> <p>There could be other unknown health concerns through changing plant chemistry that is for human consumption. (Article 1 and 2)</p>	
GM crops as part of agricultural practices and their impact on the environment	<p>GM crops are part of a trend over the past 150 years towards more intensive agricultural techniques, which can have negative effects on biodiversity but can encourage protection of uncultivated land, which protects biodiversity. (Article 3)</p> <p>Golden Rice can be grown in the same way as normal rice, so no need to change any cultural practices by local growers (Article 3) but could divert from an ecologically friendly form of farming and food production. (Article 2)</p> <p>Possibility of Golden Rice contaminating other rice supply chains in the same way as variety LL601 in Louisiana State (Article 2) or GM crops contaminating other ecosystems. (Article 1)</p> <p>The National Academy of Science (USA) and over 500 independent scientific research groups have found that crops produced by genetic modification are no more of a risk than conventional plant breeding technology.(Articles 1 and 3)</p>	<p>Ethical Social Economic Environmental</p> <p>Ethical Social Economic Environmental</p> <p>Environmental</p> <p>Environmental Ethical</p>
Golden Rice is supported by humanitarians but opposed by activists	<p>Humanitarians believe that GM crops could help to end food shortages and poverty, and improve health (Articles 1 and 3) but activists believe that it distracts from other solutions and has unforeseen environmental consequences. (Articles 2 and 3)</p> <p>Golden Rice is a humanitarian project donated by its inventors and funded by philanthropists, such as the Rockefeller and Gates Foundations. (Articles 2 and 3)</p> <p>Activists, such as Greenpeace and Friends of the Earth, hamper progress in the development of genetic engineering techniques and Golden Rice crops were destroyed in the Philippines in 2013. (Article 3)</p> <p>Moral pressure to save lives places pressure on organisations and institutions opposed to GM crops. (Article 2)</p>	<p>Ethical Social Economic Environmental</p> <p>Ethical Social Economic</p> <p>Ethical Social Economic Environmental</p> <p>Ethical Social</p>
Political and economic implications of GM crops	<p>Some parts of the world use GM crops (e.g. USA, Asia) whilst other parts do not (e.g. European Union, Africa). (Articles 1, 2 and 3)</p> <p>European Union court ruling about stricter regulations on GM crops will also influence developing countries</p>	<p>Ethical Social Economic Environmental</p> <p>Ethical</p>

	<p>and there could be a drop in exports of GM crops from the USA as a result. (Article 1)</p> <p>Adoption of Golden Rice in Asian countries could add at least US\$6.4 billion to their GDP due to health benefits and increased productivity. (Article 3)</p> <p>Golden Rice technology is given freely by its inventors, costs no more than normal rice and would be a cheaper source of Vitamin A than animal products or supplements (Article 3) but may be a "Trojan Horse" for commercial industries to profit. (Articles 2 and 3)</p> <p>GMOs gain funding from philanthropic and governmental sources but could have spent it instead on supporting other vitamin deficiency programmes. (Article 2)</p>	<p>Social Economic Environmental</p> <p>Social Economic Environmental</p> <p>Ethical Social Economic</p> <p>Ethical Social Economic</p>
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Question 2: *Identify the different organisations / individuals mentioned in the articles and suggest how they may have an influence on the scientific issue. (6 marks)*

Assessment focus	Band 0	Band 1	Band 2	Band 3
Understanding the influence of different organisations / individuals	0	1-2	3-4	5-6
	Level of response not worthy of credit	<ul style="list-style-type: none"> Demonstrates adequate knowledge and understanding of how key organisations/ individuals can influence the scientific issue by identifying different types of organisation/individual. A basic explanation of how the organisation/individual may have an influence is given but with general statements made and limited linkages to the articles. 	<p>Demonstrates good knowledge and understanding of how key organisations/individuals can influence the scientific issue by identifying different types of organisation/individual (including any references/acknowledgments in footnotes) from all three articles.</p> <p>An explanation of how these organisations/individuals may influence the issue is given, which is occasionally supported through linkage and application to the articles.</p>	<p>Demonstrates comprehensive knowledge and understanding of how key organisations/ individuals can influence the scientific issue by identifying and selecting different types of organisation/individual (including any references/acknowledgments in footnotes) from all three articles.</p> <p>An explanation of how these organisations/individuals may influence the issue is given, which is supported throughout with linkage and application to the articles.</p>

Indicative content

Learners:

- **May include other valid suggestions, not listed below, which should be credited.**
- **May cover a number of examples from the list below.**
- **Would NOT be expected to cover all points to get full marks.**

Government and global organisations	
Organisation	Influence on scientific issue
European Union / European Commission (Article 1 and 3)	Restricted use of GMOs in member states. EU regulation of GMO restricts the increased use of GM crops in Europe and may influence non-European countries
USA government / Department of Agriculture (Article 1 and 2)	Grows / monitors GM crops, key exporter of GM produce and may influence other countries
Indian government (Article 3)	Adopting Golden Rice widely in the country would benefit the economy and may influence other countries
United Nations (Article 3)	Monitors and recognises Vitamin A deficiency as a significant public health problem, so could encourage or discourage Golden Rice as a world solution
World Health Organisation (Article 3)	Monitors and recognises Vitamin A deficiency as a significant public health problem, so could encourage or discourage Golden Rice as a world solution

Non-governmental organisations	
Organisation	Influence on scientific issue
International Rice Research Institute (Article 2 and 3)	International non-profit research group, oversees Golden Rice projects and will continue to invest in research and development of GMOs
Helen Keller International (HKI) (Article 2)	International non-governmental organisation, promotes and runs eye health and nutrition programmes, which do not include Golden Rice or GM solutions

Universities and research groups	
Organisation	Influence on scientific issue
National Academy of Science (USA) (Article 1)	Academic institution that claims there is no evidence that GMOs are a risk
US Universities (Cornell, North Carolina State, Iowa State, Louisiana State) (Article 1)	Academic institutions that have plant and agriculture research groups and representatives who support research and development on GM crops
University of Freiburg, ETH Zurich and Swiss National Science Foundation (Article 2)	European research institutions that funded initial research into Golden Rice

Private and multinational organisations	
Organisation	Influence on scientific issue
Syngenta (Article 3)	Global agrochemical company, which collaborated, developed and scaled up Golden Rice production, and will have a vested interest in developing GMOs
Bill & Melinda Gates Foundation (Article 2)	Private philanthropic organisation. Aims to end extreme poverty and enhance healthcare and education in the world; funding for food-security projects
Rockefeller Foundation (Article 2)	Private philanthropic organisation, funding for food-security projects, improve the wellbeing of humanity around the world

Voluntary and pressure groups	
Organisation	Influence on scientific issue
Greenpeace (Article 2 and 3)	Non-governmental environmental organisation, opposed to GM crops, and will raise public awareness / lobby governments on anti-GMO
Friends of the Earth (Article 1)	Non-governmental environmental organisation opposed to GM crops, and will raise public awareness / lobby governments on anti-GMO
French agricultural union (Article 1)	Non-governmental organisation, opposed to GM crops

Journals and magazines	
Organisation	Influence on scientific issue
Science (USA edition) (Article 3)	Published Golden Rice "proof of concept" research, condemned destruction of Golden Rice field trial, provides a scientific basis but only a national viewpoint
Nature (UK edition) (Article 3)	Would not publish Golden Rice "proof of concept" research, provides a scientific basis but only a national viewpoint
Time Magazine (US edition) (Articles 2 and 3)	Published a cover story article about the benefits of Golden Rice, provides a journalistic basis but only a national viewpoint
Greenpeace Press Releases (Articles 2 and 3)	Published various articles promoting alternative Vitamin A deficiency strategies and campaigning against GM crops such as Golden Rice
American Society of Clinical Nutrition (Article 3)	Published research showing Golden Rice as a high source of Vitamin A but later retracted

Individuals	Influence on scientific issue
Matthew Willmann (Article 1)	Director of the Plant Transformation Facility at Cornell University, "not just affecting Europe, you're affecting the world"
Dana Perls (Article 1)	Senior food and agricultural campaigner at Friends of the Earth, welcomes EU ruling and dangers of gene editing
Jeffrey Wolt (Article 1)	Professor of agronomy and toxicology at Iowa State University, dismayed by ruling and misunderstanding surrounding GM crops
Bill and Melinda Gates (Article 2)	Billionaire philanthropists in favour of Golden Rice and creating food-security for the world
Ingo Potrykus and Peter Beyer (Article 3)	Inventors of genetic modification to produce Golden Rice
Nobel Laureate Economists (Article 3)	Golden Rice is "the best bang for a buck"
Ye et al (Articles 2 and 3)	Scientists, first Golden Rice prototype in "Engineering the provitamin A β -carotene biosynthetic pathway into (carotenoid-free) rice endosperm"
Bushamuka et al (Article 2)	Scientists, examined benefits of alternative food-based strategies
Talukder et al (Article 2)	Scientists, reported benefits of lowered risk of night blindness in children via a programme that does not involve the use of Golden Rice
de Pee et al (Article 2)	Scientists, study of pro-vitamin A carotenoid intake via a non-Golden Rice programme
Taher et al (Article 2)	Scientists, study of Bangladeshi mothers and children's daily pro-vitamin A carotenoid consumption via a non-Golden Rice programme
Tang et al (Article 3)	Scientists, study of bioconversion of β -carotene in Golden Rice into vitamin A (paper later retracted by American Society of Clinical Nutrition)

Credit reference to **farmers as individuals** – choosing whether to grow GM crops.

Credit reference to **consumers as individuals** – choosing whether to purchase and consume GM food.

Credit reference to **religious groups or indigenous peoples as individuals or organisations** – the altering of nature / life; going against religious or cultural belief.

Question 3: Discuss whether Article 3 has made valid judgements. (12 marks)

Assessment focus	Band 0	Band 1	Band 2	Band 3	Band 4
Interpretation, analysis and evaluation of scientific information	0	1-3	4-6	7-9	10-12
	Level of response not worthy of credit	<ul style="list-style-type: none"> Vague statements about the validity of Article 3 are made with limited attempt to consider: <ul style="list-style-type: none"> how the article has interpreted and analysed the scientific information to support the conclusions/ judgements being made the validity and reliability of data references to other sources of information. The discussion will be unstructured and limited to basic points made. 	<ul style="list-style-type: none"> The validity of Article 3 is discussed, which is partially supported by a consideration of: <ul style="list-style-type: none"> how the article has interpreted and analysed the scientific information to support the conclusions/ judgements being made the validity and reliability of data references to other sources of information. The discussion shows some structure and coherence. 	<ul style="list-style-type: none"> The validity of Article 3 is discussed, which is mostly supported by a consideration of: <ul style="list-style-type: none"> how the article has interpreted and analysed the scientific information to support the conclusions/ judgements being made the validity and reliability of data references to other sources of information. The discussion shows a structure that is mostly clear, coherent and logical. 	<ul style="list-style-type: none"> The validity of Article 3 is discussed and is consistently supported throughout by the consideration of: <ul style="list-style-type: none"> how the article has interpreted and analysed the scientific information to support the conclusions/ judgements being made the validity and reliability of data references to other sources of information. The discussion shows a well-developed structure that is clear, coherent and logical.

Indicative content

Learners should consider how the article has analysed the scientific information to support the conclusions / judgements being made; the validity and reliability of data; references to other sources of information.

Learners:

- **May include other valid suggestions, not listed below, which should be credited.**
- **May cover a number of examples from the list below.**
- **Would NOT be expected to cover all points to get full marks.**

Conclusions/judgements:

- Golden Rice has potential to prevent child death or blindness from Vitamin A deficiency.
- Costs are minimal and could improve productivity and economic growth.
- GM crops have the potential to help to provide food-security for humankind.
- GM crops are a natural extension of agricultural technological development over the past 150 years and selective breeding over 10-12,000 years.
- No evidence to indicate unsafe to humans, animals or the environment.
- Golden Rice can be genetically modified to target other micronutrient deficiencies.
- Political, regulatory and environmental group opposition has slowed widespread use, but those attitudes are changing.

Validity and reliability:

- Author has worked as a research scientist, in UK Ministry of Agriculture, Fisheries and Food (now called Defra), for Syngenta and is on the Golden Rice Humanitarian Board.
- Some bias in favour of Golden Rice and GM crops but both arguments presented.
- Author still publishing and has currency in the field.
- Review takes a historic / geographic / political approach rather than a scientific approach.
- Opinions backed with data and references.
- Cites published research that showed modification of rice to produce beta-carotene, and showed that the human body efficiently converts beta-carotene into Vitamin A and that consumption of 40g of Golden Rice daily will save lives.
- No published results presented within the review to support this position.
- Large range of sources referred to, including scientific research papers and periodicals.
- Research from different authors' papers would seem to be in agreement.
- More advantages than disadvantages presented so may not be balanced.
- Data used to justify the need for Golden Rice (e.g. food production, global mortality from Vitamin A deficiency).
- Original data from reputable sources (e.g. map of Vitamin A deficiency from the WHO).
- Purpose of the paper is to convince and influence people rather than show evidence.

References:

- Referenced throughout.
- Refers to professional bodies.
- References are generally recent / from the 1990s to the last few years.
- Nothing past 2017.
- References from a variety of sources.
- Sometimes quoting their own research.
- May be more current research that disagrees.

Question 4: Suggest potential areas for further development and/or research of the scientific issue from the three articles. (5 marks)

Assessment focus	Band 0	Band 1	Band 2	Band 3
Interprets, analyses and evaluates articles to identify potential areas for further development and/or research	0	1	2-3	4-5
	Level of response not worthy of credit	<ul style="list-style-type: none"> Areas for further development and/or research of the scientific issue are identified but these are usually vague descriptions with limited analysis/evaluation of the articles to support the statements being made. 	<ul style="list-style-type: none"> A description for further areas of development and/or research of the scientific issue is given. Provides occasional evidence from the analysis/evaluation of the articles and attempts to synthesise and integrate relevant knowledge. 	<ul style="list-style-type: none"> A description for further areas of development and/or research of the scientific issue is given. Consistently provides evidence from the analysis/evaluation of the articles and demonstrates throughout the skills of synthesising and integrating relevant knowledge.

Indicative content for question 4

Learners:

- **May include other valid suggestions, not listed below, which should be credited.**
- **May cover a number of examples from the list below.**
- **Would NOT be expected to cover all points to get full marks.**

Further research / development needed on:

- Cross-contamination of GM crops with other plants.
- Health and safety of humans and animals consuming GM food.
- Effectiveness of Golden Rice as a treatment for Vitamin A deficiency compared to other treatments.
- Other micronutrients that could be added to Golden Rice or other GM crops, such as iron, zinc or other vitamins.
- Other plants and crops that could be genetically modified, e.g. potato, tomato.

Issue specific research / development:

- Drought and heat resistant crops so that they can withstand long periods without water or can still survive dry seasons.
- Salinity tolerant crops so that they could be grown in areas of high salt water / coastal areas.
- More efficient photosynthesis so that crops can grow more rapidly or better in areas with fewer hours of sunlight / low intensity sunlight.
- Disease and pest resistance so that healthy crops can be grown.
- Use of CRISPR-Cas9 in other gene editing projects of rice and other staples (eg introduce nitrogen-fixing genes)

Wider research:

- Use of more efficient, alternative non-synthetic technologies and solutions, e.g. organic fertilisers.
- Use of more efficient, alternative treatments of vitamin A deficiency, e.g. dietary diversification.
- Quantities of Golden Rice that can be consumed.
- Other properties that may be desirable in crops (eg nitrogen fixation).

Credit any other valid suggestions.

Question 5: You are a junior researcher working for the European Commission for Health and Food Safety. The European Commission decides whether genetically modified crops can be used. Many people have concerns about the use of genetically modified crops. Your task is to write a report about the benefits and concerns of using genetically modified crops. Your report will be sent to the European Commission, a group of professionals. The professionals are not all scientists. (15 marks)

Assessment	Band 0	Band 1	Band 2	Band 3	Band 4
	0	1-4	5-8	9-12	13-15
Synthesises content ideas and demonstrates an understanding of scientific reporting and its relationship with reporting medium and target audience	Level of response not worthy of credit	<ul style="list-style-type: none"> Identifies some of the main points and evidence from the three articles with limited attempt to summarise these. Shows little awareness of audience or purpose. The article will be unstructured and limited to basic points made. 	<ul style="list-style-type: none"> Summarises the main points and evidence, including any supporting and conflicting statements, from the three articles. Shows an awareness of audience and purpose. The article shows some structure and coherence. 	<ul style="list-style-type: none"> Summarises and attempts to synthesise the main points and evidence, including any supporting and conflicting statements, from the three articles. Selects material to suit audience and purpose, with appropriate use of tone, style and scientific terminology. The article shows a structure that is mostly clear, coherent and logical. 	<ul style="list-style-type: none"> Summarises and synthesises the main points and evidence, including any supporting and conflicting statements, consistently from the three articles. Consistently selects and organises material for particular effect, with effective use of tone, style and scientific terminology. The article shows a well-developed structure that is clear, coherent and logical.

Indicative content for question 5

Learners:

- **May include other valid suggestions, not listed below, which should be credited.**
- **May cover a number of examples from the list below.**
- **Would NOT be expected to cover all points to get full marks.**

Tone and style shows awareness of audience:

- Broad audience but educated.
- Professionals, some of whom may have a limited scientific background.
- Report needs to be professional and structured.
- Explains what a genetically modified crop is.
- Scientific terms would be used but explained clearly.
- Needs to be authoritative / fact-based opinion.
- Needs to be balanced focus on benefits and concerns.
- Provides sources of further reading around the subject.

Main Points

Benefits:

- Crop can be modified to have better properties.
- Needs fewer resources (i.e. fertiliser, water, sunlight, pesticides).
- Increase yield / reduce wastage.
- More food for EU and world population / eradicate starvation and poverty.
- Can improve population health (e.g. reduce vitamin A, iron deficiencies, exposure to pesticides).
- More profitable / less need to import food into the EU.
- Technology need not be expensive / many are developed/funded by philanthropists.
- Research suggests that it is no less safe than conventional forms of plant breeding.

Concerns:

- Expense of research and development / private companies profiting.
- Cross contamination of non-GM crops and wild plants.
- Reduction in biodiversity.
- Health and safety of humans / animals consuming GM food.
- Reduction of diversity in diets / health treatments.
- Environmental protests / politically controversial.
- Diversion of funding from other sustainable agriculture methods / treatments for nutrient deficiencies
- Technology in infancy / more research needed / more development needed.

Conclusion

- GM crops have more benefits / drawbacks.
- Use of supporting/conflicting statements from the three articles

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