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INTERNATIONAL SECONDARY CERTIFICATE EXAMINATION
MAY 2023

BIOLOGY: PAPER II
MARKING GUIDELINES

Time: 2 hours

100 marks

These marking guidelines are prepared for use by examiners and sub-examiners, all of whom are required to attend a standardisation meeting to ensure that the guidelines are consistently interpreted and applied in the marking of candidates' scripts.

The IEB will not enter into any discussions or correspondence about any marking guidelines. It is acknowledged that there may be different views about some matters of emphasis or detail in the guidelines. It is also recognised that, without the benefit of attendance at a standardisation meeting, there may be different interpretations of the application of the marking guidelines.

SECTION A**QUESTION 1**

- 1.1 1.1.1 Plasmid
1.1.2 Restriction (enzyme)
1.1.3 Clone
- 1.2 The GR is an organism made by inserting a piece of DNA/a gene from one species (daffodil) into a different species (to rice).
- 1.3 1.3.1 (a) Other planned solutions for malnutrition as well as programs currently in place are cheaper/better Golden Rice produces the least amount of beta-carotene compared to other crops. / could have risks and concerns (e.g. allergies, crops are expensive to grow, rice produces low yields) (mark any ONE)
- (b) Most of Africa has severe/critical VAD. Information from the map shows that most of Africa is dark grey, showing critical VAD
Addressing VAD will significantly reduce deaths and diseases.
Accept statistics such as 250 million pre-school children affected/ vitamin A supplements could prevent 2,7 million childhood deaths. (mark any ONE)
- 1.3.2 Carrots $125/3,57 =$ approximately 35 times (or in words – 125 $\mu\text{g/g}$ beta-carotene in carrots compared to 3,57 $\mu\text{g/g}$ beta- carotene in Golden Rice = 35 times)
- 1.3.3 45% of 19 million = 8,55 milion
- 1.4 1.4.1 Heading: diagram of a nucleotide
Drawing must show 3 components – phosphate, sugar, nitrogenous base (all three components must be correct)
all components connected together correctly; N-base and phosphate to sugar molecule
- 1.4.2 Thymine/T-base present no T in RNA; double stranded – RNA is single stranded. Accept only visible reasons
- 1.4.3 Transcription
- 1.4.4 (UCU) CAA GCA
- 1.4.5 Different codons result during transcription in the mutant DNA. This results in different amino acids coded for – instead of ser and arg, ser and gly is coded for
- 1.4 6 No – mutation is a change in the order or types of nucleotides in a gene. A new gene is inserted in the rice genome.
Yes – number of nucleotides/identity of nucleotides/order of N-bases has changed.

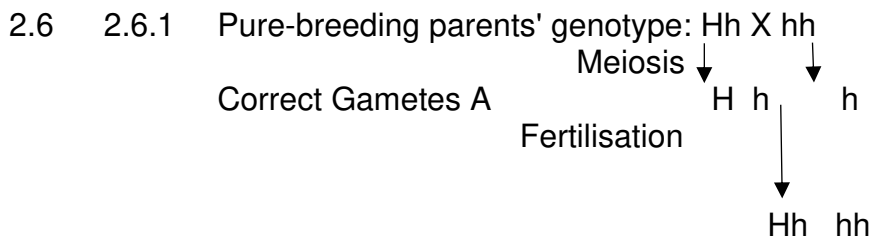
1.5 Table comparing opinions relating to support of and opposition to Golden Rice

	OPPOSITION TO GOLDEN RICE	IN SUPPORT OF GOLDEN RICE
Beta-carotene levels	1. Does not make enough beta-carotene to make a difference	1. Consuming yellow rice can make a difference if used together with other interventions
Cost	2. Seed for GM crops is expensive	2. Seeds for Golden Rice have been provided for free to developing countries
Health	3. Risks associated with consuming GM such as antibiotic resistance/allergies	3. All commercial GM crops have been shown to have no difference in food safety/ The new proteins expressed in this rice are not similar to any known allergen or toxin/ New proteins disintegrate in the digestive system
Environmental effects	4. Could cross-breed and contaminate wild rice or pass genes to other species	4. No environmental effects have been noted

Must be comparative.
Mark first TWO

QUESTION 2

- 2.1 2.1.1 D
- 2.1.2 A
- 2.1.3 B
- 2.2 2.2.1 An organism that is homozygous for a characteristic/producing offspring homozygous for a characteristic by breeding parents together who are homozygous for a characteristic
- 2.2.2 The first generation of a genetic cross
- 2.3 Resistance to disease, ability to withstand high temperatures, produce large quantities of meat or milk, ability to walk far, ability to swim, horns to dissipate heat, coat colour Mark FIRST 2
- 2.4 2.4.1 Picture of chromosomes in a dividing cell paired into homologous sets organised from large to small, with the last pair sex chromosomes Mark ANY two
- 2.4.2 $2n = 30/60$ chromosomes/30 pairs
- 2.4.3 Male Y chromosome is present/NOT XX present gonosomes different sizes
- 2.5 2.5.1 Picture of pieces/bands of DNA separated based on size characteristic of a particular individual/specific DNA pattern obtained from an individual Mark ANY two
- 2.5.2 (a) A
- (b) B
- 2.5.3 Non-coding
Coding DNA codes for proteins therefore DNA tends to have a more similar order and number of N-bases between cattle as it makes up genes. Therefore, changes would probably be undesirable, and those cattle wouldn't have survived.
Non-coding DNA isn't used as it does not code for proteins, therefore it is highly variable and if an animal is born with mutations, it can still survive and pass on these mutations. Therefore, it will tend to be more variable. Mark any THREE (1 mark for why NOT coding DNA and 2 marks for why it IS non-coding DNA or vice versa)



Punnett square

Parental genotypes	H	h
h	Hh	hh
h	Hh	hh

(1 for gametes; 2 for correct F1 genotypes)

2.6.2 50% horned 50% hornless

- 2.7 Crossbreeding involves two different individuals reproducing and passing on gametes. Gametes are produced by meiosis. In meiosis, crossing-over takes place / chromatids of the homologous chromosomes break off and exchange genes / crossing over results in reshuffling of genetic material / Independent assortment – orientation of each of the bivalents occurs independently, therefore there is a different arrangement of maternal and paternal chromosomes that can be inherited when bivalents separate in anaphase 1. Therefore, it is totally random which alleles for different characters are passed onto offspring. Mark any THREE separate points

SECTION B**QUESTION 3**

The application of CRISPR-Cas9 technology will play an important role in eliminating health and food challenges facing Africa.	
Agree/Support	Do NOT agree
SOURCE A Some positive applications – treatment of diseases (e.g. dengue, Chagas, Lyme disease), eliminate invasive species, alter threatened organisms, eliminate weedy plants, modify research animals Gene drive can be used to produce mosquitoes that are all male Therefore little mating can occur and very few mosquitoes are born in the next generation, reducing the population substantially It can also involve producing individuals that are resistant to a certain parasite – they can pass on this ability to be resistant to the parasite	SOURCE A
SOURCE B Greenpeace unreliable source Provides food security in the face of climate change. Increasing yield / resistance to drought/floods/insects/pathogens Successful growth of cassava – staple diet in large parts of Africa CRISPR used for removal of toxic substances Bananas important food source and source of income in parts of Africa – resistance to BXW bred in bananas produced by CRISPR	SOURCE B Greenpeace unreliable source Use of editing techniques could increase negative effects of farming on people, farm animals and biodiversity Increases likelihood of transfer to other species converting ecosystem into a laboratory Removes concept of free choice to not consume GM food if no laws to identify presence of GM crops in food items in EU Leaves food and biodiversity in the hands of large organisations (95% GM maize and soybeans in Africa owned by a few companies) who may not have much concern for people's health or environment 18 African countries have banned GM maize, many African countries have voluntary labelling of GM foods Gene editing could occur at the wrong target site in the DNA resulting in mutations affecting multiple genes leading to production of toxins/allergens Unintentional effects on various processes also occurred in study on camelina: production of plant hormones / fatty acids was affected. Changes can affect food webs. Edited plants could hybridise with wild species leading to unintended effects in subsequent generations. Plant could become invasive
SOURCE C Many deaths due to malaria (for quoting figures / facts to prove increase in malaria / increase in deaths)	SOURCE C Success in a few laboratory studies not sufficient to allow release of gene-edited organisms into the environment

Genetic editing can be used to eradicate malaria – deleting the <i>FREP1</i> gene in mosquitoes made them develop more slowly into adults, less likely to feed on blood meals and laid fewer and less viable eggs also working on mosquitoes that have been modified so that they cannot transmit malaria	Unintended consequences need to be avoided – due to mutations in the altered organisms, transfer of the edited genes into other related organisms, (this point mentioned already in Source B) and transformation of ecosystems Other ways to prevent malaria – nets, artemisinin, repellents, early detection, good sanitation (CAP at 2 if listed)
SOURCE D Justification for the experiment was to provide HIV immunity HIV deaths still high (therefore justifiable to try to solve problem with CRISPR) for quoting figures / facts from source to prove high HIV death rate.	SOURCE D The first people to be gene-edited may have been mutated in a way that shortens life expectancy Professor Jiankui acted illegally Method was full of technical errors and ethical mistakes – data had not been published or peer reviewed, so many of the details of his experiment were unclear, not clear if participants were aware of what they were signing up for no training in how to obtain consent Condemned by scientists, application of gene editing on human embryos for reproductive purposes was unethical Since been fired from his university post and under investigation from Chinese authorities A court in China sentenced He Jiankui to three years in prison for carrying out 'illegal medical practices' HIV deaths and infections dropping (therefore no justification to try to genetically modify people to be resistant to it)

OWN INFORMATION Negative impact of chromosomal mutation using any described disease. Only a few economically stronger nations can invest in CRISPR to make profit. Africa is still battling with a lot of other socio-economic challenges that should be prioritised. There is a number of other known medically successful ways to prevent HIV transmission rather than the dangerous CRISPR route used on the birth of the twins. Control of organisms that carry disease Alter organisms that are threatened or endangered Eliminate weed species Alter model organisms being used for research Dispelling much of Greenpeace article could be done with own info	OWN INFORMATION Elaboration on what a clone is and impact on the spreading of the BXW diseases. Elaboration on the superiority of CRISPR over any identified and explained traditional crop and animal breeding as well as older genetic engineering techniques. Some GM crops linked to wildlife loss, soil impoverishment, emergence of 'super bugs' and 'super weeds' – extension of the idea of alien invasive species on sensitive African biomes Extension on dominance of African technology by Western companies
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Total: 100 marks

Note: Essay should be 2½ to 3 pages long.

Time allocation suggestion: Reading of sources 10 min.; Planning 10 min.; Writing essay 40 min.

	1 mark	2 marks	3 marks	4 marks	Possible mark (40)
Planning × 2	- Decision given. - Key points present for and against the argument.	- Decision given. - Key points developed for and against the argument.	- Decision given. - Key points developed for and against the argument. - Source references identified (e.g., Source A/ own information).		6
Decision	- Vague. - Changed position within essay.	Clear decision made.			2
Use of knowledge from sources × 2	Up to ¼ of potential detail in sources used to support argument.	Up to ½ of potential detail in sources used to support argument.	Up to ¾ of potential detail in sources used to support argument.	Source detail – very close to full potential used to support argument.	8
Use of own knowledge	Some facts given beyond the source to support argument.	Many facts given beyond the source to support argument.	- Some facts given beyond the source to support argument. - Facts integrated into the argument.	- Many facts given beyond the source to support argument. - Facts integrated into the argument.	4
Content relevance	- Repetition mostly avoided. - Some minor digression. - Supporting argument relevant.	- Repetition mostly avoided. - Some minor digression. - Supporting argument relevant. - Quality of source extracts acknowledged.			2

	1 mark	2 marks	3 marks	4 marks	Possible mark (40)
Quality of argument supporting decision × 2	- Writing consists of facts with little linkage or reasoning. - Reasoning incorrect	Maximum if no clear decision in support. - Reasoning correct, but hard to follow. - Ordinary: some linkage evident.	- Supports the position. - Reasoning is clear. - Minor errors in flow. - Linkage sometimes missed.	- Strongly supports a clear position. - Reasoning is very clear and succinct. - Flow is logical. - Compelling with regular linkage. - Well-integrated argument.	8
Fairness – counter opinions to decision	One to two counter opinions given from the sources.	Three to four counter opinions given from the sources.	Integration of one to two counter opinions from the sources into argument.	Integration of three to four counter opinions from the sources into argument.	4
Presentation	- Writing is almost unintelligible. - Tone, language, terminology unscientific and very weak. - Introduction and/or conclusion not present.	- Tone, language, terminology weak. - Introduction and conclusion present.	- Tone is consistent and suited to scientific language. - Good and appropriate language and terminology. - Mostly appropriate paragraphing. - Introduction and conclusion have merit.	- Tone is mature and suited to scientific language. - Excellent and appropriate language and terminology. - Correct paragraphing with good transitions - Interesting. introduction, satisfying conclusion.	4
Scientific merit	Essay shows academic rigour, accurate reasoning, insight and cohesiveness.				2