



GCE Biology

S21-A400U20-1

Assessment Resource 16

Continuity of Life Resource G

Answer all questions.

1. Gregor Mendel published his laws of heredity in 1866. He carried out breeding experiments using the garden pea, *Pisum sativum*. He investigated the inheritance of characteristics that had at least two distinct forms or traits. He developed varieties of peas that were **pure breeding** for the traits of each characteristic that he investigated. He determined that characteristics are inherited as '**units of inheritance**' and that while some units of inheritance always appear in the offspring produced from a cross, others did not.

(a) (i) State the term currently used in genetics to describe the form or trait of a characteristic. [1]

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(ii) Explain what is meant by the term **pure breeding**. [1]

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(iii) Mendel's '**units of inheritance**' are now known as alleles. Explain why some characteristics always appear in the offspring produced from a cross, while others do not. [2]

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Pea flowers are insect-pollinated and contain both female and male reproductive organs. In many of his experiments, Mendel prevented self-pollination and self-fertilisation by removing the male reproductive organs and cross-pollinating the flowers by hand. In other experiments he allowed plants to self-pollinate by preventing cross-pollination.

- (b) (i) Name the male reproductive organs and explain how their removal would encourage cross-pollination. [2]

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- (ii) Suggest how Mendel could have prevented cross-pollination. Explain your answer. [1]

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- (d) In the early 1900s, further genetic crosses were carried out to investigate inheritance in the garden pea. They studied two characters, flower colour – purple or red, and the shape of pollen grains – long or round. They crossed plants that were pure breeding for purple flowers and long pollen grains with plants pure breeding for red flowers and round pollen grains. The F_1 were allowed to self-fertilise to produce the F_2 generation. The results of this cross are shown in table 1.2.

Table 1.2

Characteristics	Number of offspring
purple flower, long pollen grains	4831
purple flower, round pollen grains	390
red flower, long pollen grains	393
red flower, round pollen grains	1338

- (i) Suggest why this cross did not produce the same ratio of the combination of characters as found by Mendel in his experiment. [1]

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- (ii) Using your knowledge of meiosis, explain how plants producing purple flowers and round pollen grains could have been produced in this cross. [2]

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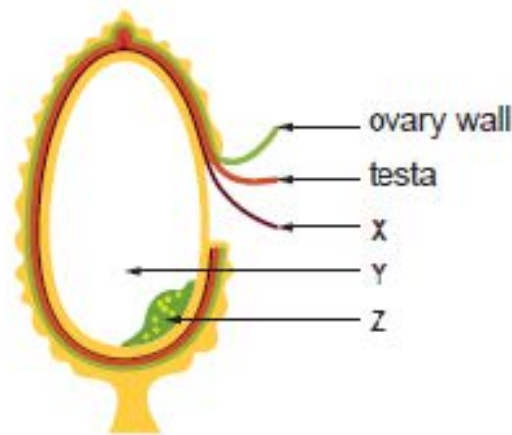
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2. Rice, *Oryza sativa*, is a staple food crop for over half of the world's population. It provides most of the carbohydrate intake for people in many countries. Image 2.1 shows the structure of a rice grain.

Image 2.1



During processing of rice grains for consumption, most rice is 'polished' leaving only starch-containing tissue. This is called white rice. Brown rice retains fibre and protein-containing tissues.

- (a) (i) Using the letters X, Y and Z, identify the following: [3]

I. the structure that would stain blue-black on application of iodine solution.

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II. the source of gibberellins during germination of a rice grain.

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III. the main source of amino acids for a germinating rice grain.

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- (ii) Most rice consumed in Asian countries is white rice. In some areas rice makes up 80 to 90% of the diet. Suggest how and why the processing of rice has led to reduced growth rates of children in some communities. [2]

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Vitamin A deficiency is a world-wide problem. Rice can be genetically modified to include the gene coding for beta carotene which is then used in the production of vitamin A. This modified rice is yellow in colour and is called 'golden rice'.

In the first experiments to genetically modify rice, a pathogenic bacterium, *Agrobacterium tumefaciens*, was used to transfer the genes required to produce beta carotene into rice cells using modified plasmids.

- (b) Name and describe the function of two enzymes that could have been used to produce the modified plasmids transferred to *A. tumefaciens*. [2]

Enzyme 1

Function

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Enzyme 2

Function

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- (c) One of the genes required for beta carotene synthesis was obtained from daffodil DNA. Due to the presence of introns in the daffodil gene, a better option might be to use a synthetic DNA sequence derived from mRNA rather than using a gene extracted directly from a daffodil chromosome.

- (i) State what is meant by an *intron*. [1]

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(ii) Explain how post transcriptional modification of mRNA (splicing) in eukaryotic cells provides evidence against the 'one gene one polypeptide' hypothesis. [2]

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(iii) Explain why a synthetic DNA sequence derived from mRNA might be the better option for genetically modifying rice cells. [3]

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(iv) Outline the process by which a synthetic daffodil gene could be prepared from mRNA. [3]

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(d) The production of 'golden rice' is still in progress despite trials showing that humans can utilise the beta carotene contained in 'golden rice' to produce vitamin A. Suggest why people may still be opposed to the wide-scale growing and use of 'golden rice'. [2]

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