BIOLOGY

Paper 9790/01
Part A Multiple Choice

Question Number	*Key*	*Question Number*	*Key*
1	**C**	21	**B**
2	**A**	22	**D**
3	**B**	23	**A**
4	**D**	24	**A**
5	**B**	25	**B**
6	**D**	26	**A**
7	**C**	27	**D**
8	**A**	28	**A**
9	**C**	29	**A**
10	**B**	30	**D**
11	**B**	31	**C**
12	**C**	32	**A**
13	**C**	33	**B**
14	**D**	34	**C**
15	**A**	35	**D**
16	**B**	36	**D**
17	**C**	37	**C**
18	**A**	38	**C**
19	**D**	39	**A**
20	**D**	40	**B**

General comments

Most questions were answered correctly by the majority of candidates. The questions which the candidates found most challenging are described below.

Comments on specific questions

Question 6

Some candidates applied their understanding of prokaryotes and eukaryotic organelles to solving this problem. Of the options, only nuclei have a similar complexity. Prokaryotes have a membrane, nucleic acids and ribosomes so their density would be much more likely to be in the range of the nuclei than of other much simpler, small or fragmentary organelles.

Question 8

The most popular answer was the correct answer, showing that some candidates had realised that post-translational modification was the explanation for the information. Candidates need to take care that whilst options may be correct biologically they may not be the answer in the context of the information provided, for example whilst 'mRNA does bind to the rRNA in the second codon position' this does not explain the information provided in the question. Similarly, whilst post-transcriptional modification does occur, this involves introns and exons rather than excision of single terminal triplets from genes.

Question 10

Most candidates recognised this organ as the pancreas. Of the four organs listed, only the pancreas has clumps of cells (islets of Langerhans) that look like this in photomicrographs.

Question 14

Most candidates deduced the correct answer using the information provided in the question, including that which can be seen in the photomicrograph, combined with knowledge from the syllabus. To identify D correctly the candidates needed to realise that the cornea does not have its own blood supply (to enable it to be transparent) but that the cells would still have normal amounts of protein / antigen.

Question 18

From the information provided, some candidates, with understanding of epistasis, were able to work out that this was dominant epistasis in which the epistatic allele was P.

Question 26

Candidates needed to have a clear understanding of the cohesive forces being between the molecules in water and not between the water molecules and the sides of the xylem vessels (adhesion) to eliminate statement 2 and that the maximum density of water is at $4^{o}C$ and not its minimum to eliminate statement 4. Only option A does not include either statement 2 or statement 4.

Question 29

Whilst candidates correctly identified mitochondrion and chloroplast as being able to produce ribosomes as these organelles contain them, some candidates incorrectly selected endoplasmic reticulum as producing ribosomes.

Question 30

Some candidates realised that the results of low water potential of the environment of the plants would be similar for xerophytes and halophytes and therefore that it might be expected that halophytes would possess all of the characteristics given for xerophytes.

Question 38

Most candidates read the question, statements and options carefully and realised that that the answer was in terms of small habitats differing from larger habitats. Under these circumstances, biodiversity decreases, competition increases and abundance of large animals decreases. Invasive species will not penetrate either small areas or large areas significantly unless there has been considerable destruction of the habitat. The most satisfactory answer therefore excludes this statement.

Question 40

Candidates who read the information carefully as 'to slow down the spread of HIV' realised that inhibition of reverse transcriptase would slow down the spread of this RNA virus. Inhibition of restriction endonucleases would not be relevant to eukaryotes such as humans. Restriction endonucleases have rarely been used therapeutically owing to the risk of fragmentation of the genome. Reverse transcriptase is a constitutive enzyme of HIV and treatment of patients with it would not slow the spread of HIV.

BIOLOGY

Paper 9790/02

Paper 2 Structured

Key Messages

- The syllabus includes topics that deal with microorganisms, animals and plants. Candidates should appreciate the equal weighting that is put on these three groups within the syllabus. **Question 4** in this paper was about plant biology and was less well answered than the other questions.

General comments

The paper showed that candidates coped well with the content of the Pre-U Biology syllabus. There were many accurate and concise answers. The candidates tackled a range of question styles with confidence and were particularly impressive in **Question 3** on genetic engineering. **Question 1** proved to be a good opening question for the paper.

Comments on specific questions

Question 1

There are many references to prokaryotes in the syllabus. This question asked for details of structure and size of a bacterium and for details of identification using the Gram staining technique. None of these topics proved difficult for most of the candidates.

(a) The candidates identified the cell shown in Fig. 1.1 as a prokaryote or a bacterium and then identified the labelled parts of the cell correctly. In **(iv)**, the calculation of the actual size of the bacterium was completed successfully by most.

(b) The best explanations of differential staining using the Gram staining technique were very thorough. There was some confusion about the composition of the outer layers of Gram positive and Gram negative bacteria.

Question 2

This question on biochemistry was tackled confidently by the candidates. Making a diagram to show the formation of a glycosidic bond between two β-glucose molecules in **(a)** was one of the more demanding tasks on the paper.

(a) Fig. 2.1 shows two β-glucose molecules. In **(i)**, the candidates had to draw a diagram to show how these molecules bond together. Showing that a water molecule is produced proved the easiest part of this task. Some showed the bond as forming between an –H and an –OH group rather than between two –OH groups. For credit to be awarded, the candidates had to show that one of the glucose molecules is rotated so that the oxygen atoms in the rings of glucose are opposite each other. All correctly named the bond as glycosidic in **(ii)**.

(b) Several acceptable similarities and differences between ribose and β-glucose were given.

(c) Candidates identified advantages of condensing α-glucose as starch. Candidates should avoid the word 'affect' without being more specific. The storage of insoluble compounds does affect the water potential of a cell, but candidates need to make it clear that they do not decrease water potential as glucose molecules would do. There were good references to the easy mobilisation of glucose from the branched polymer, amylopectin. This idea was also given in **(ii)** in relation to the high energy needs of mammals. A variety of other answers were accepted, even the obvious one that as all animals store glycogen it is not surprising that mammals have inherited the genes for this from their reptilian ancestors. The fact that glycogen is more readily hydrolysed needed more explanation in terms of its highly branched structure with many 'ends' available for mobilisation of glucose.

Question 3

The answers to this question on Golden Rice™ were very confident indeed.

(a) Candidates referred to the genetic code as being universal or as common to all organisms.

(b) The role of the endosperm-specific promoter was described carefully in **(i)** and there were detailed explanations of the insertion of DNA into the plasmid from *Agrobacterium tumefaciens* in **(ii)**. The reason for using the tumour inducing (Ti) plasmid was explained successfully in **(iii)**. All candidates gave biolistics or microprojectiles as another method to insert DNA into cells of monocotyledonous plants.

(c) There were excellent answers explaining the term *rate-limiting step* in a metabolic pathway such as the production of β-carotene.

(d) This question prompted a number of sensible suggestions as to what further genetic engineering was carried out to increase the concentration of β-carotene in the rice seeds. Candidates suggested inserting more copies of the gene for *psy* and using a more effective promoter. Some discussed the roles of the gene products.

(e) Candidates were less sure about the risks to the environment and to human health of growing and eating GM crops. This was surprising given all the publicity given to this topic in recent years. The idea of transfer of antibiotic resistance genes to gut bacteria is a risk, but not in making people resistant to antibiotics.

Question 4

Candidates were much more secure in their knowledge of the structure and function of striated muscle and the roles of calcium ions than they were in explaining how adult stem cells could differentiate into cell types needed for repair of tendons.

(a) The term *multipotent* was defined effectively in **(i)**. Descriptions of the control of mitosis in **(ii)** concentrated on the roles of external agents, such as cytokines and mitogens, and to production of kinase enzymes. Candidates made good references to mitosis checkpoints during the cell cycle. Less impressive were the explanations of differentiation of adult stem cells in **(iii)** to form the cell types in a tendon. Candidates did not make the obvious point that each stem cell has a complete genome including the genes for connective tissue cells and endothelial cells that are required to repair the extracellular matrix of tendons and their blood supply.

(b) The candidates explained the differences between the transverse sections of parts of a myofibril given in Fig. 4.1. They identified the thick and thin filaments and stated that **P** is a cross section of the A band, **Q** of the I band and **R** of the H zone.

(c) Calcium ions play a role as secondary messengers in the release of neurotransmitters from motor neurones and in the excitation-contraction coupling mechanism within muscle tissue. Candidates showed impressive knowledge of this role in muscle, but often overlooked the release of neurotransmitter, perhaps not realising that this was covered by the question.

Question 5

This question was based on **Section 5** of the syllabus and was set in the context of the evolution and conservation of the takahē, a flightless bird that is endemic to New Zealand.

(a) Explanations of the evolution of flightless birds in New Zealand were not very detailed. It is perhaps difficult to explain selection for this feature. Candidates mentioned the absence of predators, but did not make it clear that flying requires considerable energy and there is little advantage to be gained by flying if there is no need to escape from predators, travel between feeding grounds and nesting sites or migrate. With no predators and few, if any competitors, flightlessness became an advantageous feature as it did on other islands, such as Mauritius.

(b) Candidates outlined the threats to species of flightless birds of New Zealand. They referred to introduced species and the damage that they have done. Candidates did not include the threats to survival that exist when populations are small and isolated. This is a topic in the syllabus which was relevant here and cued by the information at the beginning of the question.

(c) This question introduced the ideas of the fundamental niche and the realised niche. Candidates were expected to use the information provided to suggest how knowledge of these ideas would inform decisions made about the conservation of an endangered species. Again, the information in the question could have been developed to compare, for example, the survival of the takahē in alpine grasslands where it feeds on tussock grasses and the islands where it feeds on pasture grasses. Conditions on the islands may be less than perfect, but they do allow survival and could be improved by careful management to replicate some of the conditions where they are successful.

Question 6

The Examiners were surprised that candidates did not all give four features of xylem vessels and explain how these are adaptations to function. Descriptions and explanations of the patterns of transpiration and water absorption in loblolly pine and prickly pear cactus, shown in Fig. 6.1, were not always as precise as expected.

(a) The mark scheme lists eight features of xylem vessels. Candidates often gave some structural features but rarely gave appropriate explanations of the adaptations. For instance, xylem vessels have no cross walls or cellular contents. This gives low resistance to flow or allows a continuous flow of water. Walls are thickened to provide mechanical support and prevent collapse under tension. Some candidates suggested that the thickened walls prevented positive pressure so that the vessels did not burst. Adhesion of water to walls of xylem vessels is to the hydrophilic cellulose rather than to hydrophobic lignin.

(b) Part **(i)** required a description and explanation of rates of transpiration and water absorption of the loblolly pine. Candidates were expected to refer to transpiration as loss of water *vapour* and the idea that transpiration drives water absorption. This explains the delay between the times of maximum rates of transpiration and water absorption. There were good comparative comments, although some misread the units for the *y*-axis. In **(ii)**, candidates gave good explanations why the prickly pear has much lower rates of transpiration and water absorption. They stated that prickly pear is a xerophyte and gave at least one xeromorphic feature.

Question 7

Fig. 7.1 showed changes in the concentration of 17β-oestradiol during the follicular phase of the menstrual cycle. Answers to **(b)** and **(c)** did not often refer to the concepts of negative feedback and blocking oestrogen receptors.

(a) The specific site of oestrogen secretion was required in answer to **(i)**. The Examiners looked for the term *follicle*, not the ovary. The descriptions of oestrogen on the uterus in **(ii)** were often good.

(b) The action of oestrogen and progesterone in the combined contraceptive pill was not always related to the negative feedback that occurs during the menstrual cycle. The effects of these hormones on the anterior pituitary were described in terms of leading to a decrease in concentration of FSH. Rarely was there any inclusion of the effects on the hypothalamus with the reduction in secretion of gonadotrophin-releasing hormone (GnRH).

(c) Descriptions of the mode of action of the fertility drug, clomiphene, were not very detailed. Candidates referred to interaction with gonadotrophin-secreting cells in the anterior pituitary, but rarely referred to the oestrogen receptors that are blocked by clomiphene or to events that happen following this interaction.

BIOLOGY

Paper 9790/03

Long Answer

Key Messages

Paper 3 is intended to be challenging and, whilst being fully accessible throughout the range, to discriminate in particular between D1, D2, D3, M1 and M2. It seeks to test a range of the skills required to equip a candidate for higher education including the ability to;

- acquire a core of factual knowledge and understanding of biological concepts as outlined in the specification,
- to make extended answers in continuous prose,
- apply knowledge in unfamiliar contexts,
- interpret and evaluate numerical and other forms of unfamiliar data,
- think synoptically,
- integrate new knowledge into an existing framework of knowledge and understanding to generate new understanding,
- write an essay combining the selection of appropriate factual content with skills of synopticity, balance, effective written communication, and argumentation.

General comments

This year's Pre-U Biology candidates are to be commended on an impressive performance on a challenging examination which tested a range of skills.

Section A (**Questions 1** to **4**) consisted of four short questions based on different parts of the specification. **Section B** consisted of a series of three linked questions (**Questions 5** to **7**) which required the synoptic application of knowledge and understanding of several parts of the specification concerned with evolutionary processes integrated with knowledge of mitochondria and genetics. An unfamiliar context was provided by stimulus material about human evolution which was introduced progressively throughout this Section.

Section C required candidates to select one essay title from a choice of three (**Questions 8** to **10**). **Question 9** was by far the most popular. No candidate attempted **Question 10**. In this type of essay candidates receive credit primarily by using their knowledge of the topic. To gain a good score for scientific content it was necessary to combine elements from different parts of the specification in a smoothly synoptic fashion. Partial credit is available for writing style. This included;

- a clear, logical progression of ideas,
- good use of terminology,
- good standards of grammar and spelling,
- the production of a balanced account,
- the demonstration of skills of argumentation addressing the issue given in the title.

Comments on specific questions

Question 1

This was set in a relatively familiar context requiring recall of knowledge of antibodies as an example of protein synthesis from DNA transcription to the release of a protein product from a cell by exocytosis. This question was generally well done.

Question 2

This examined the application of knowledge of plant growth from the specification in the context of unfamiliar data**.** This too was generally well done.

Question 3

The question required candidates to apply and to synthesise knowledge of blood circulation and to compare mammalian vascular systems with those of fish and amphibians. Part **(b)** proved more searching than it appeared to be at first sight but nevertheless there were many good responses.

Question 4

Candidates were required to apply knowledge and understanding from the specification on photosynthesis, photorespiration and C3 and C4 plants. They were also expected to analyse and interpret unfamiliar graphical data. Some candidates found this question quite demanding, but nevertheless the Examiners noted good responses.

Question 5

This question opened **Section B** by introducing 'mitochondrial Eve' with a comprehension passage in the style of *New Scientist*. The passage was designed to lead candidates into the topic with some direct questions from relevant parts of the specification content on mitochondria including their origin and their function. Most candidates responded well to this aspect of the question. Part **(c)** was more synoptic and challenging. This required candidates to piece together the sequence of events from fertilisation to the differentiation of muscle cells. They were asked to consider zygotes that contain mitochondria of maternal origin and to think about the division of both cells and mitochondria.

Question 6

Candidates were led further into this topic with some more stimulus material including unfamiliar data which required careful analysis. Most realised that **(a)** was about PCR and were able to describe it correctly. Parts **(b)** and **(c)** were more discriminatory but there were some good responses especially in **(c)** in which candidates were asked to suggest a simple phylogeny relating modern humans, Neanderthals and chimpanzees implied by the stimulus material. There were some good answers that evaluated the data and drew some conclusions from it.

Question 7

Most candidates found this question quite challenging although there were some good attempts at **(b)** where candidates were asked to discuss why it was difficult to decide whether modern humans and Neanderthals should be regarded as separate species. Candidates found **(a)**, which required an explanation of the expression 'relatively neutral in terms of evolution', quite demanding. Part **(c)** required a synthesis of knowledge, concepts and hypotheses introduced progressively throughout **Section B** and provided discrimination within those working at distinction level.

Question 8

Candidates could gain credit for demonstrating knowledge of how ecosystems work and clearly defining relevant terms, such as keystone species. However, to gain further credit candidates needed to link these not only to an understanding of the term *sustainable* but to apply it specifically to human populations.

Question 9

All candidates who tackled this question gained credit for describing the homeostatic control of blood glucose concentration in humans. The challenge to be met in achieving credit was to explore several examples of how cells communicate with each other and to link them together in a *balanced* essay. In order to be successful, candidates needed to get beyond just presenting several examples by exploring what is meant by 'the body *can only function properly* when the cells are in constant communication'. Not all candidates who concentrated on control of blood glucose concentration realised that diabetes provided a good straightforward illustration of the consequences of poor communication between cells.

Question 10

No candidates attempted this question which probably appeared more difficult than it really would have proved. It was essentially about the characteristics of living organisms and the means by which these characteristics might be demonstrated. No specific knowledge of the Martian environment was expected although to achieve credit candidates might have benefitted from some speculation as they placed their discussion in its extra-terrestrial context.

BIOLOGY

Paper 9790/04

Practical

Key Messages

- Centres should check all the requirements for the examination. If they need to make any substitutions they should make these clear in the Supervisor's Report. It is important that any slides supplied are checked carefully well before the date of the examination. If they are not of the highest standard then Centres should contact Cambridge immediately for replacements.
- In relation to the conduct of the exam, it should be stressed how important it is that Centres follow closely the requests made in the Confidential Instructions under the heading 'Responsibilities of the Supervisor during the Examination'.
- Candidates may present answers in this paper as bullet points or numbered points. This is especially the case when describing a practical procedure or writing a plan. The use of numbered points is recommended since it is easy to refer to individual steps by number.

General comments

This Practical Examination consists of two Sections. **Section A** has two practical tasks, one of which involves the use of a microscope. **Section B** has a Planning Exercise and two data analysis questions. The paper tests many skills from planning, experimentation and data presentation to analysis and interpretation. Candidates achieving Distinction level on this paper have shown impressive facility at these skills especially considering the variety of tasks to be completed within 2 ½ hours.

The candidates presented data appropriately and showed good understanding of statistical methods to analyse secondary data provided in both **Sections**. Sound knowledge and understanding of the histology of the stomach and small intestine were shown in **Question 2**. The importance of clear and careful drawing, labelling and annotating need to be emphasised to future candidates recording the observations that they make with a hand lens and/or microscope.

Most of the candidates showed good numerical skills and a sound appreciation of statistical methods. The more able could draw concise and effective conclusions from the results of the two statistical tests in **Section B**.

Comments on specific questions

Question 1

Candidates had to investigate the effect of changing the time that milk was in contact with lactase immobilised in calcium alginate beads. They did this by measuring the concentration of glucose as the product. The apparatus provided included syringe barrels containing the beads with short lengths of tubing attached. A clip on the tubing allowed candidates to hold milk within the syringe barrel for different lengths of time. Concentrations of glucose were determined by using Diastix ® test strips.

(a) All the candidates presented their results to an appropriate degree of precision in well-designed tables. The readings showed the expected trend.

(b) The candidates described ways in which they used the apparatus to gain reliable results. It was not possible in the time available to carry out replicate results, but credit was available for suggesting that this would be done. Detailed answers included discarding the first drops taken from the syringe as this included lactose solution that had not been in contact with the lactase beads. Candidates described ways in which they standardised the timing method and the washing of the column of beads. Use of numbered points in these answers would have perhaps saved candidates some time.

(c) All candidates stated that the standard deviation or standard error should be calculated to assess the reliability of the secondary data presented in Table 1.1. The candidates also used data to good effect in making comparisons between the relative activities of soluble and immobilised lactase.

Question 2

The candidates were provided with slides of the stomach (**P1**) and small intestine (**P2**) of a small mammal. These were not identified so that candidates would not immediately use their knowledge and past experience of similar slides to answer the questions. Candidates had to make labelled and annotated drawings, take a measurement and use it to calculate the magnification of their drawing and make comparisons, in the form of a table, between **P1** and **P2**.

(a) In **(i)**, candidates made a low power plan drawing of the section of stomach wall. Most of these showed the relative thickness of the different tissues and were labelled appropriately. In **(ii)**, the magnifications were calculated correctly. In future, candidates may also be expected to estimate the uncertainty in the measurements made from microscope slides or from specimens. Low power plans do not have to show the full extent of the section on the slide. Candidates can draw sectors that show the relationships between the tissues visible.

(b) The mucosa of the stomach has three cell types that are present in large numbers:

- mucous neck cells,
- parietal / oxyntic cells,
- peptic / chief cells.

The candidates were expected to make drawings of two of these cell types although they did not have to identify them. They were expected to annotate their drawings to show the differences between their chosen cells. Differences in position and appearance of nuclei, staining of nuclei and cytoplasm, overall shape, size and distribution are examples of features that candidates could use in this type of question.

(c) The candidates tabulated their comparisons of **P1** and **P2** although none included a third column to list the features that they had chosen to compare. Almost all made direct comparisons, although there were a few blank cells in the table where an appropriate comment for either **P1** or **P2** had not been included. The presence of villi and crypts of Leiberkühn in the small intestine were contrasted with the rugae in the stomach; comparisons between the thickness of the muscularis mucosa and muscularis externa in the two organs were included. The candidates showed an impressive knowledge of appropriate terminology in this question.

(d) Almost all candidates stated that the electron micrograph of the columnar epithelial cell showed microvilli which are adaptations for increasing the surface area for absorption.

Question 3

The Planning Exercise involved determining changes in the respiratory quotient (RQ) of two types of seed during germination. This exercise involved two major aspects:

- determination of RQ at different stages of germination,
- seeds with different storage products.

Most of the candidates understood that the procedure needed to be carried out on the two sets of seeds under identical conditions. However, there was less appreciation of the need to take readings of oxygen uptake and carbon dioxide release at intervals during germination to follow the changes in RQ. The Examiners assumed that the candidates considered germination to be an instantaneous event even though in the introduction to the question it states that they are expected to follow the *changes* in RQ.

The plans stated suitable hypotheses to test, outlined a suitable strategy with good use of detail, considered control variables and assessed any risks. Rather too much space was given to identifying the independent and dependent variables. Candidates were unsure about how to determine the volume of carbon dioxide released using the simple respirometers when soda lime was not used. Candidates should have explained that the meniscus in the capillary tube may move away from the syringe if RQ is greater than 1, towards the syringe if it is less than 1 and stay at the same position if RQ = 1. Ways to calculate the carbon dioxide production knowing the rate of oxygen uptake should also have been included. Seeds that store carbohydrate would be predicted to have an RQ of 1, seeds that store lipids an RQ of less than 1. Seeds also interconvert substances during germination so RQ values often change as this happens. Candidates could also state that respiration might be anaerobic which would have an effect on the RQ.

Planning Exercises will always be set on one or more learning outcomes from the syllabus but will also rely on the descriptors for the various practical skills outlined in the syllabus. This means that the practical procedure to be used should be familiar to the candidates, but the context in which it has to be used may be one that they had not considered before. This means that this question has an element of problem solving.

Question 4

This question gave information on a popular field-work investigation comparing the linear dimensions of dogwhelk populations on sheltered and exposed shores.

(a) The candidates were not always certain why it is important to take random samples in such an investigation. Some mentioned the bias in results that would result from non-representative sampling.

(b) This question prompted several excellent answers. The idea that rulers were not the best apparatus to use for measuring the dogwhelks was a suitable initial critical comment on the method for obtaining data in this investigation. This comment needed further elaboration for the award of any marks. The uncertainty was given as ± 0.5 mm although candidates rarely stated that there would be uncertainty at both ends of the ruler when taking results because of difficulty in aligning the ruler with the animal. The ruler is likely to give inaccurate measurements for an organism with no flat surfaces over which to position the ruler. Methods of calculating percentage uncertainty were given correctly although the idea that all results should be given with the uncertainty was not.

(c) Table 4.1 showed data for the ratio of aperture length to total length for the dogwhelks in the two samples. The candidates explained the idea that dogwhelks vary in size so a parameter was necessary that was independent of size or age.

(d) This question stated that a t-test had shown that the *P* value for the difference between the means for the ratios was less than 5 %. Candidates were expected to state that the null hypothesis should be rejected as the *P* value shows there is a significant difference between the ratios and that the probability that the result is due to chance alone is less than 5 %. Part **(ii)** proved to be the most challenging question on the paper. Candidates did not use the information provided at the start of the question for ideas about how to answer this more general question.

Question 5

This question involved a χ^2 test carried out on data from a dihybrid cross involving two unlinked genes that control features of pollen grains in maize.

(a) All candidates gave the correct genotype of the maize plant.

(b) Most candidates gave the correct genotypes of the pollen grains realising that they are haploid. Some gave a variety of diploid genotypes.

(c) If the χ^2 table was filled in correctly the value of 5.20 was obtained. It is important that candidates include the negative sign when calculating O – E. Several candidates gave the null hypothesis in

general terms when the question referred specifically to this example. The degrees of freedom were given correctly. Candidates were less successful at stating, with a reason, whether the calculated value for χ^2 supported the assumption that the two genes are unlinked. The best answers used Table 5.3 and referred to the probability lying between 0.50 and 0.10.