2022 HSC Biology Marking Guidelines

Section I

Multiple-choice Answer Key

Question	Answer
1	B
2	C
3	A
4	B
5	B
6	D
7	D
8	B
9	D
10	B
11	A
12	A
13	C
14	A
15	C
16	C
17	B
18	A
19	D
20	D

Section II

Question 21 (a)

Criteria	Marks
• Outlines ONE way that a pathogen can pass between hosts	2
• Provides some relevant information	1

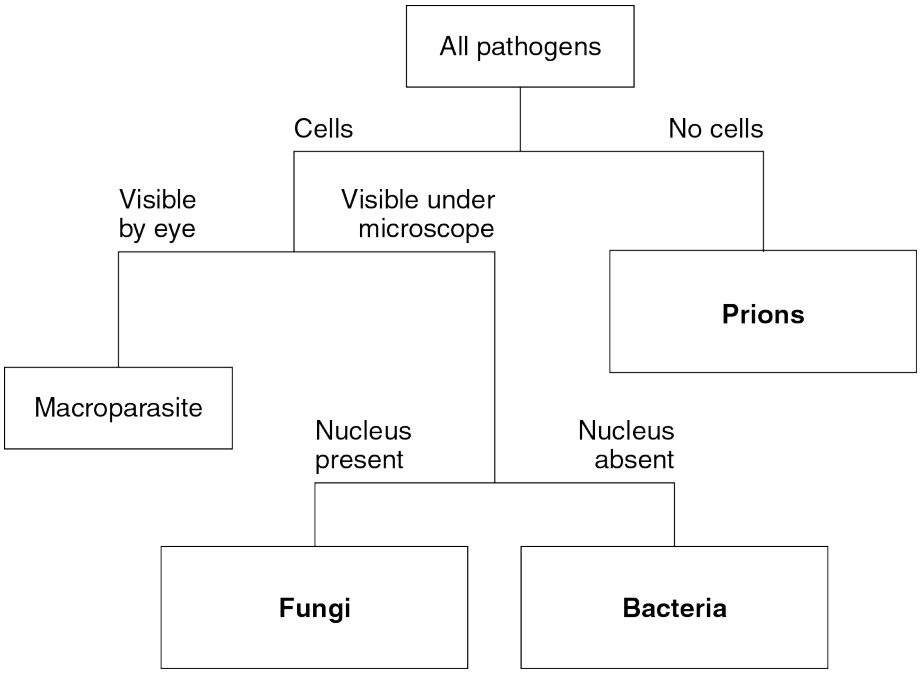
Sample answer:

Viral particles emitted by one person can be transferred directly through the air and inhaled by another person.

Question 21 (b)

Criteria	Marks
• Completes key with suitable pathogens	3
• Completes some steps in the key correctly	2
• Provides some relevant information	1

Sample answer:



Answers could include:

Examples of named pathogens from the relevant group.

Question 22

Criteria	Marks
• Provides the correct phenotypic ratio of the offspring • Provides correct parental genotypes and suitable working	3
• Provides the correct phenotypic ratio of the offspring • Provides some suitable working OR • Identifies correct parental genotypes • Provides suitable working OR • Provides appropriate parental genotypes • Provides suitable working and relevant phenotypic ratio	2
• Provides some relevant information	1

Sample answer:

Both colours are dominant due to blending/both being expressed.

Dark purple = PP

White =WW

Violet = PW

	P	W
P	PP	PW
W	PW	WW

Phenotypic ratio

Dark purple	:	Violet	:	White
1		2		1

Question 23 (a)

Criteria	Marks
• Outlines the process of artificial pollination	2
• Provides some relevant information	1

Sample answer:

This process involves the transfer of pollen from the anther of one target plant to the stigma of another targeted plant.

Question 23 (b)

Criteria	Marks
• Explains an outcome of the use of artificial pollination	2
• Provides some relevant information	1

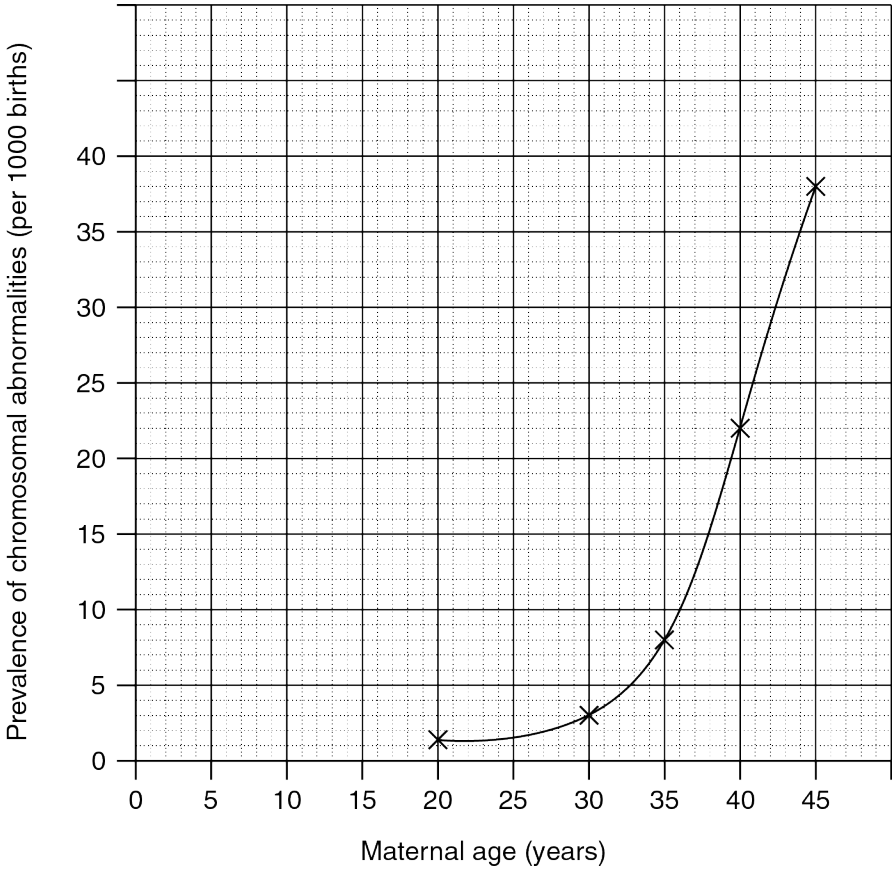
Sample answer:

If the pollen from one plant is used to artificially pollinate a large number of plants, this will lead to a large number of offspring that are similar. Over time, if this is repeated in subsequent generations this will reduce the genetic diversity of the population.

Question 24 (a)

Criteria	Marks
• Provides a suitable graph • Provides a graph that is correctly drawn including labels and scale for axes, points plotted correctly, appropriate line of best fit	3
• Provides a graph that includes most aspects correctly	2
• Provides suitable aspects of a graph	1

Sample answer:



Question 24 (b)

Criteria	Marks
• Outlines the main features of the trend	2
• Identifies a trend	1

Sample answer:

As maternal age increases, the prevalence of chromosomal abnormalities increases. After the age of 30, there is a rapid increase in prevalence – it is increasing at an increasing rate.

Question 24 (c)

Criteria	Marks
• Identifies a type of chromosomal mutation • Explains the cause of the mutation	3
• Outlines the cause of a chromosomal mutation	2
• Provides some relevant information about a chromosomal mutation	1

Sample answer:

One type of chromosomal mutation is a numerical abnormality. This is where there are more or fewer chromosomes than the normal diploid cell. These abnormalities can be caused during meiosis due to non-disjunction. Non-disjunction means that a pair of homologous chromosomes fails to separate/segregate during meiosis so that some of the gametes have one chromosome too many and some of the gametes have one chromosome too few.

Answers could include:

Chromosomal alterations such as deletions, duplications, inversions or translocations.

Question 25

Criteria	Marks
• Provides similarity and differences in the ways genetic variation can arise in offspring derived from asexual reproduction and sexual reproduction • Differentiates between mitosis in asexual reproduction and meiosis in sexual reproduction • Demonstrates a comprehensive understanding of the sources of variation in the offspring of sexual reproduction	6
• Provides a similarity and difference(s) in the ways genetic variation can arise in offspring derived from asexual reproduction and sexual reproduction • Differentiates between mitosis in asexual reproduction and meiosis in sexual reproduction • Demonstrates a clear understanding of the sources of variation in the offspring of sexual reproduction	5
• Provides a similarity and/or differences in the ways genetic variation can arise in offspring derived from asexual reproduction and sexual reproduction • Outlines processes in meiosis that contribute to variation in sexual reproduction	4
• Provides a similarity and/or difference(s) about genetic variation in offspring derived from asexual reproduction and sexual reproduction	3
• Provides some information about the variation in offspring derived from asexual reproduction and/or sexual reproduction	2
• Provides some relevant information	1

Sample answer:

Mutation during DNA replication is a source of genetic variation that can arise in offspring of both asexual reproduction and sexual reproduction.

Asexual reproduction is achieved by cells of one organism dividing by mitosis and differentiating into a new organism with the same genetic code as the parent. The most likely cause of genetic variation among the offspring would be mutations that occur due to environmental factors or miscopying of the chromosomes during mitosis.

Variation in the offspring resulting from sexual reproduction also can be due to mutations during DNA replication. However, sexual reproduction leads to much more genetic variation in offspring due to the production of gametes by meiosis. Random assignment of chromosomes of each homologous pair to the gametes and the possible recombination of alleles from crossing over of genetic material between homologous pairs of chromosomes lead to each gamete having a unique set of alleles. In addition, the chance that any one gamete from one individual has of combining with another gamete from a second individual at fertilisation leads to infinite variation in the offspring of sexual reproduction.

Question 26

Criteria	Marks
• Provides a logical procedure to test the effectiveness of Jelly Bush honey as an inhibitor of bacterial growth • Provides independent variable, dependent variable, variables kept constant and the use of a control • Includes appropriate safety considerations • Includes repetition	5
• Provides a logical procedure to test the effectiveness of Jelly Bush honey as an inhibitor of bacterial growth • Provides most of the features of a safe valid investigation such as – independent variable, dependent variable, variables kept constant and the use of control – includes repetition	4
• Provides a procedure to test the effectiveness of Jelly Bush honey as an inhibitor of bacterial growth • Provides some features of a valid investigation	3
• Provides some features of a relevant investigation	2
• Provides some relevant information	1

Sample answer:

1. Select appropriate safety equipment including gloves and safety clothing.
2. Prepare three nutrient agar plates, using sterile techniques. Seal one plate and label as control.
3. Inoculate the remaining plates with bacteria to cover the agar surface.
4. Place a sterile paper disc soaked in distilled water in the middle of an agar plate. Seal and label as Water.
5. Place a sterile paper disc soaked in Jelly Bush honey in the middle of an agar plate. Seal and label as Honey.
6. Incubate the plates at 25°C for 48 hours.
7. Remove from incubator but do not open any of the plates after incubation.
8. Observe the control plate to check for any contaminating bacteria.
9. For each agar plate, measure the zone of inhibition from edge to edge.
10. Repeat the experiment three more times and calculate an average.

Answers could include:

- Direct application of honey
- Incorporation of honey into agar plates
- Concentration of methylglyoxal.

Question 27

Criteria	Marks
• Provides an extensive evaluation of the success of the campaigns on the incidence of cervical cancer based on a detailed analysis of the stimulus • Provides a well-informed judgement as to the success of the campaigns	6
• Provides a thorough evaluation of the success of campaigns on the incidence of cervical cancer based on an analysis of the data • Provides an informed judgement as to the success of the campaigns	5
• Provides an evaluation of the success of campaigns on the incidence of cervical cancer with reference to the data • Provides a judgement	4
• Provides some points about the effect of the campaign(s) on the incidence of disease • Makes link(s) to the data	2–3
• Provides some relevant information	1

Sample answer:

The national screening program that started in 1991 is followed by a large drop in the incidence of the disease, to about half, and therefore appears to have been effective in preventing the disease. However, it is not possible from these numbers to imply that the program was the cause of the drop as other factors may have changed concurrently. Also, incidence was dropping before 1991 and this decrease may have continued without the program.

Because human papillomavirus (HPV) causes most cervical cancers, vaccinating young girls against HPV could be an effective strategy for disease prevention in addition to screening. A program that includes vaccination of the whole population including boys will reduce the circulating viral load and is expected to add to the effectiveness. However, the data do not show a reduction in the incidence of cervical cancer since the beginning of these vaccination programs. This could be because the screening program is already very effective, or because the vaccines are delivered to young, school aged students and cervical cancer is likely to develop over several years and become evident in older women. Although it is expected that the incidence will reduce as a greater proportion of the total population is vaccinated, the effectiveness of each campaign separately cannot be assessed from these data.

The data show it is likely that public health programs are effective for preventing disease but they need to be continued for many years as well as studied separately before the effects can be properly assessed.

Question 28 (a)

Criteria	Marks
• Identifies the correct model	1

Sample answer:

Model 2

Question 28 (b)

Criteria	Marks
• Provides a description of DNA replication	3
• Outlines some steps in DNA replication	2
• Provides some relevant information	1

Sample answer:

An enzyme unzips the DNA, creating a replication fork. On each strand, an enzyme attaches to the original DNA nucleotides and uses them as a template. It 'reads' the bases, and adds complementary nucleotides. Another enzyme 'glues' the nucleotides together, forming a new, double stranded section of DNA.

Question 28 (c)

Criteria	Marks
• Outlines differences in DNA in prokaryotic and eukaryotic cells	3
• Outlines a difference in DNA in prokaryotic and eukaryotic cells OR • Identifies differences in DNA in prokaryotic and eukaryotic cells	2
• Provides some relevant information	1

Sample answer:

There are many differences such as prokaryotic DNA is a circular molecule found in the cytoplasm, carrying a small number of genes and not tightly coiled around histone proteins. In contrast, eukaryotic DNA is a linear molecule found in the nucleus carrying a large number of genes and tightly coiled around histone and other proteins.

Question 29 (a)

Criteria	Marks
• Provides cause and effect for the increase in cotton yield	2
• Provides some relevant information	1

Sample answer:

As the percentage of Bt cotton grown increased, so did the cotton yield. Bt cotton reduces insect attack, increasing yield.

Question 29 (b)

Criteria	Marks
• Demonstrates a thorough understanding of the links between the use of Bt cotton, insecticides, disease control and natural selection • Provides a comprehensive analysis of the data • Interprets inter-relationships between the use of genetically engineered crops and insecticides for disease control • Makes an informed judgement based on the data	5
• Demonstrates a sound understanding of the use of Bt cotton, insecticides, disease control and/or selective pressures • Provides an analysis of the data • Provides a suitable judgement based on the data	4
• Demonstrates an understanding of the use of Bt cotton and disease control • Outlines the benefit(s) and limitation(s) of using Bt cotton for disease control • Supports answer with reference to the data	3
• Outlines a benefit or a limitation of the use of Bt cotton for disease control AND • Provides link(s) to the data	2
• Provides some relevant information	1

Sample answer:

The introduction of Bt cotton initially resulted in less insect damage and disease and a saving in application of insecticides.

As Bt cotton was introduced, the amount of insecticides applied to kill bollworm decreased, eventually to zero, suggesting that Bt cotton was effectively controlling disease due to bollworm. However, the data show that once most of the cotton crops grown were Bt cotton, insecticide use to kill hemiptera increased markedly to a higher level than before Bt cotton was introduced. These increased amounts of insecticides were needed to maintain high yields.

A conclusion that can be drawn is that Bt toxin killed bollworms but did not kill hemiptera. Removal of bollworms provided a survival advantage for hemiptera which became the dominant pest. Therefore, a new cause of disease in cotton was dominant and the benefit of Bt cotton for disease control was temporary.

The data show that use of a genetically engineered crop such as Bt cotton can control disease due to one pest, but removal of that pest opens the way for other pests to survive and reproduce so that disease in the crop persists due to insects. It can be concluded that Bt cotton only has short-term benefits and needs to be complemented by use of pesticides.

Question 30

Criteria	Marks
• Provides a comprehensive discussion of differences in the global distribution of malaria and its vector • Refers to the stimulus to support arguments • Provides reasons for presence of vector but no disease and absence of vector but disease located	7
• Provides a thorough discussion of differences in the global distribution of malaria and its vector • Refers to the stimulus to support arguments • Provides reasons for presence of vector but no disease and/or absence of vector but disease located	6
• Provides a discussion of differences in the global distribution of malaria and its vector • Refers to the stimulus • Provides reasons for presence of vector but no disease and/or absence of vector but disease located	4–5
• Provides reason(s) for differences or correlation in global distribution of disease and vectors	2–3
• Provides some relevant information	1

Sample answer:

A pathogen that relies on transmission by a vector such as a mosquito, for example the malaria parasite, will occur mainly in areas where the vector occurs. However, there are areas identified in Map 2 where malaria occurs but the mosquito does not, for example northern Africa. It is possible that either there is insufficient data on the mosquito in those areas, or humans carrying the parasite have travelled into them on a regular basis, maintaining the disease in the population. Although international travel may bring malaria cases to other countries where the mosquito does not occur such as Australia, the numbers of cases remain small, are treated promptly and the disease ceases to circulate.

On the other hand, there are some countries in which the mosquito is found but no disease occurs, for example Europe. In these cases, public health measures could have been effective in reducing or eliminating malaria despite the presence of the mosquito vector. Strategies that prevent transmission by the vector would be effective in reducing the incidence of disease. For example, pesticides may be used to reduce mosquito populations and hence reduce spread of disease, or insect bites might be prevented by use of bed nets/ fly screens.

Other strategies that kill the parasite or prevent its survival in a new host would also be effective and may be responsible for large areas of the world not having malaria cases despite the presence of the vector, such as North America. For example widespread use of pharmaceuticals that target the malaria parasite could be used. This may only be available to wealthier populations such as USA.

Answers could include:

- Prophylactic drugs prior to travel to new areas
- Use of gene drives to reduce mosquito populations.

Question 31 (a) (i)

Criteria	Marks
• Demonstrates a thorough understanding of the features of the methodology used • Provides a suitable judgement	4
• Demonstrates a sound understanding of the features of the methodology used • Provides a suitable judgement	3
• Demonstrates an understanding of the methodology used	2
• Provides some relevant information	1

Sample answer:

The study used large numbers of women matched for exposure to cigarette smoke in three categories and followed these women for 14 years. The numbers of women and the time period are adequate for a valid study. However, follow up over subsequent years would allow for data that are even more definitive.

The categories of women assume that they spend similar periods of time with a smoker, and that each smoker smokes a similar amount. However, in reality, the time exposure and the volume of smoke they are exposed to may vary greatly. This may compromise the data but the large cohort of women should average out this effect, so overall the method appears valid.

Question 31 (a) (ii)

Criteria	Marks
• Justifies suitable conclusions from the data	3
• Justifies a suitable conclusion from the data OR • Provides conclusions from the data	2
• Provides some relevant information	1

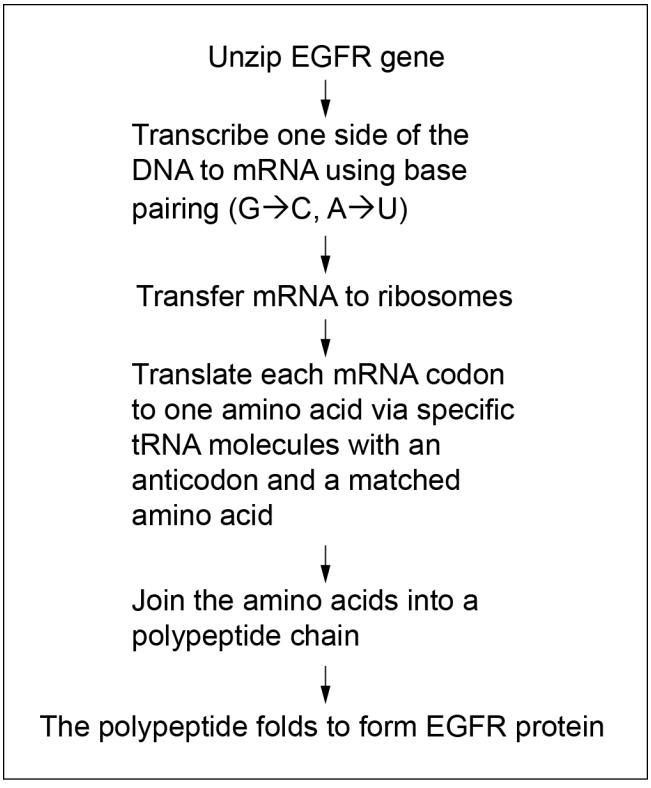
Sample answer:

Exposure to smoke either passively or actively increases the risk of dying from lung cancer, as seen by nearly double the number of deaths between non-smoker women with non-smoker husbands (8.7/100 000) compared to women with smoker husbands (15.5/100 000) or smoking women (32.8/100 000). Lung cancer can be caused by factors other than exposure to cigarette smoke as shown by the mortality rate of women who have not been exposed being 8.7/100 000.

Question 31 (b) (i)

Criteria	Marks
• Provides a suitable flow chart of EGFR synthesis that includes – gene transcription – the use of DNA and mRNA – translation – the use of mRNA, ribosomes and tRNA – the production of the protein	4
• Provides a flow chart of EGFR synthesis that includes most features of gene transcription, translation and the production of the protein OR • Provides a flow chart of protein synthesis that includes all features of gene transcription, translation and the production of the protein OR • Describes gene transcription, translation and the production of EGFR protein	3
• Provides some features of polypeptide synthesis	2
• Provides some relevant information	1

Sample answer:



Question 31 (b) (ii)

Criteria	Marks
• Explains a link between mutation, EGFR protein structure and the regulation of cell division • Links cancer to uncontrolled cell division	4
• Describes a link between EGFR mutation and protein structure • Links cancer to uncontrolled cell division OR • Describes a link between DNA, mutation and EGFR protein structure and function	3
• Outlines an effect of mutation on the EGFR protein OR • Identifies an effect of mutation on EGFR and links it to uncontrolled cell division	2
• Provides relevant information	1

Sample answer:

A mutation of the EGFR gene is a change in its DNA base sequence/codons. If this change is in a coding region of the gene it can result in a change to the amino acid sequence of the polypeptide. This may alter the folding and properties of the protein and may affect its function. For example if there is a change in the enzyme region of the protein this may alter the active site and therefore enzyme activity leading to changes that could alter the rate of DNA replication and cell division.

Lung cancer is the result of uncontrolled cell division. Since the EGFR protein is associated with controlling cell division, mutations in the EGFR gene may lead to uncontrolled cell division and therefore cancer.

Question 32

Criteria	Marks
• Demonstrates extensive knowledge and understanding of processes that could lead to differences in the gene pools of different populations, including mutation, gene flow, genetic drift and natural selection • Provides thorough explanations of processes that could result in differences in the gene pools of different populations • Uses the stimulus to support the explanations	7
• Demonstrates a thorough understanding of processes that could lead to differences in the gene pools of different populations including mutation, gene flow, genetic drift and natural selection • Provides explanations of processes that could result in differences in the gene pools of different populations • Refers to the stimulus to support the answer	6
• Demonstrates a sound understanding of processes that could lead to differences in the gene pools of the different populations • Provides explanations of processes that could result in a difference in gene pools	4–5
• Demonstrates an understanding of difference(s) in the gene pools of different populations AND/OR • Provides an outline of a process that could affect a gene pool	2–3
• Provides some relevant information	1

Sample answer:

Mutation is likely to be the underlying cause of the allele. It is unlikely that the large differences in allele frequency would be caused by mutation alone, unless it could be shown that environmental mutagens such as chemicals differed in different populations, being most prevalent in South Asia where 60% of people carry the allele.

Natural selection occurs when individuals with certain genotypes are more likely than individuals with other genotypes to survive and reproduce, and thus to pass on their alleles to the next generation. If a population was challenged with the relevant virus and it caused severe lung inflammation, natural selection could reduce the frequency of the allele, such as is seen in Africans and East Asians.

If mixing of the populations was rare, then the different frequencies may be maintained by limited gene flow. Lack of migration leads to limited mixing of populations across the wide geographic areas.

Finally, allele frequencies can change over time in a population due to chance events. This is known as genetic drift. This occurs particularly in small populations where the chance of certain individuals mating and producing offspring can change the gene frequency in the next generation, depending on the individuals that breed. In large geographic areas, the effects of chance would be averaged.

2022 HSC Biology Mapping Grid

Section I

Question	Marks	Content	Syllabus outcomes
1	1	Mod 8 Homeostasis	12-15
2	1	Mod 8 Homeostasis	12-15
3	1	Mod 7 Immunity	12-14
4	1	Mod 7 Responses to pathogens	12-14
5	1	Mod 8 Epidemiology	12-4, 12-15
6	1	Mod 5 Reproduction	12-12
7	1	Mod 6 Genetic technologies	12-13
8	1	Mod 5 Cell replication	12-12
9	1	Mod 7 Prevention, treatment and control	12-6, 12-14
10	1	Mod 7 Causes of infectious disease	12-14
11	1	Mod 7 Causes of infectious disease	12-14
12	1	Mod 5 Cell replication	12-6, 12-12
13	1	Mod 6 Mutation	12-6, 12-13
14	1	Mod 5 Genetic variation	12-6, 12-12
15	1	Mod 5 Genetic variation	12-4, 12-12
16	1	Mod 6 Mutation	12-13
17	1	Mod 5 Cell replication Mod 6 Mutation	12-6, 12-13
18	1	Mod 6 Mutation	12-13
19	1	Mod 8 Technology and disorders	12-15
20	1	Mod 8 Technology and disorders	12-15

Section II

Question	Marks	Content	Syllabus outcomes
21 (a)	2	Mod 7 Causes of infectious disease	12-14
21 (b)	3	Mod 7 Causes of infectious disease	12-7, 12-14
22	3	Mod 5 Inheritance patterns in a population	12-4, 12-12
23 (a)	2	Mod 6 Genetic technologies	12-13
23 (b)	2	Mod 6 Genetic technologies	12-13
24 (a)	3	Mod 8 Causes and effects	12-4, 12-15
24 (b)	2	Mod 8 Causes and effects	12-5, 12-15
24 (c)	3	Mod 8 Causes and effects	12-15
25	6	Mod 5 Reproduction Mod 5 Genetic variation	12-12
26	5	Mod 7 Causes of infectious disease	12-2, 12-4, 12-6, 12-14
27	6	Mod 8 Prevention	12-2, 12-5, 12-15
28 (a)	1	Mod 5 Cell replication	12-12

Question	Marks	Content	Syllabus outcomes
28 (b)	3	Mod 5 Cell replication	12-12
28 (c)	3	Mod 5 DNA and polypeptide synthesis	12-12
29 (a)	2	Mod 6 Biotechnology	12-5, 12-6
29 (b)	5	Mod 6 Biotechnology Mod 6 Genetic technologies Mod 7 Causes of infectious disease Mod 7 Prevention, treatment and control	12-5,12-6,12-13,12-14
30	7	Mod 7 Causes of infectious disease Mod 7 Prevention, treatment and control	12-5, 12-14
31 (a) (i)	4	Mod 6 Mutation Mod 8 Epidemiology	12-5, 12-15
31 (a) (ii)	3	Mod 8 Epidemiology	12-5, 12-15
31 (b) (i)	4	Mod 5 DNA and polypeptide synthesis	12-12
31 (b) (ii)	4	Mod 5 DNA and polypeptide synthesis Mod 6 Mutation	12-5, 12-15
32	7	Mod 6 Mutation	12-5, 12-13