NSW Education Standards Authority

2019 HSC Biology Marking Guidelines
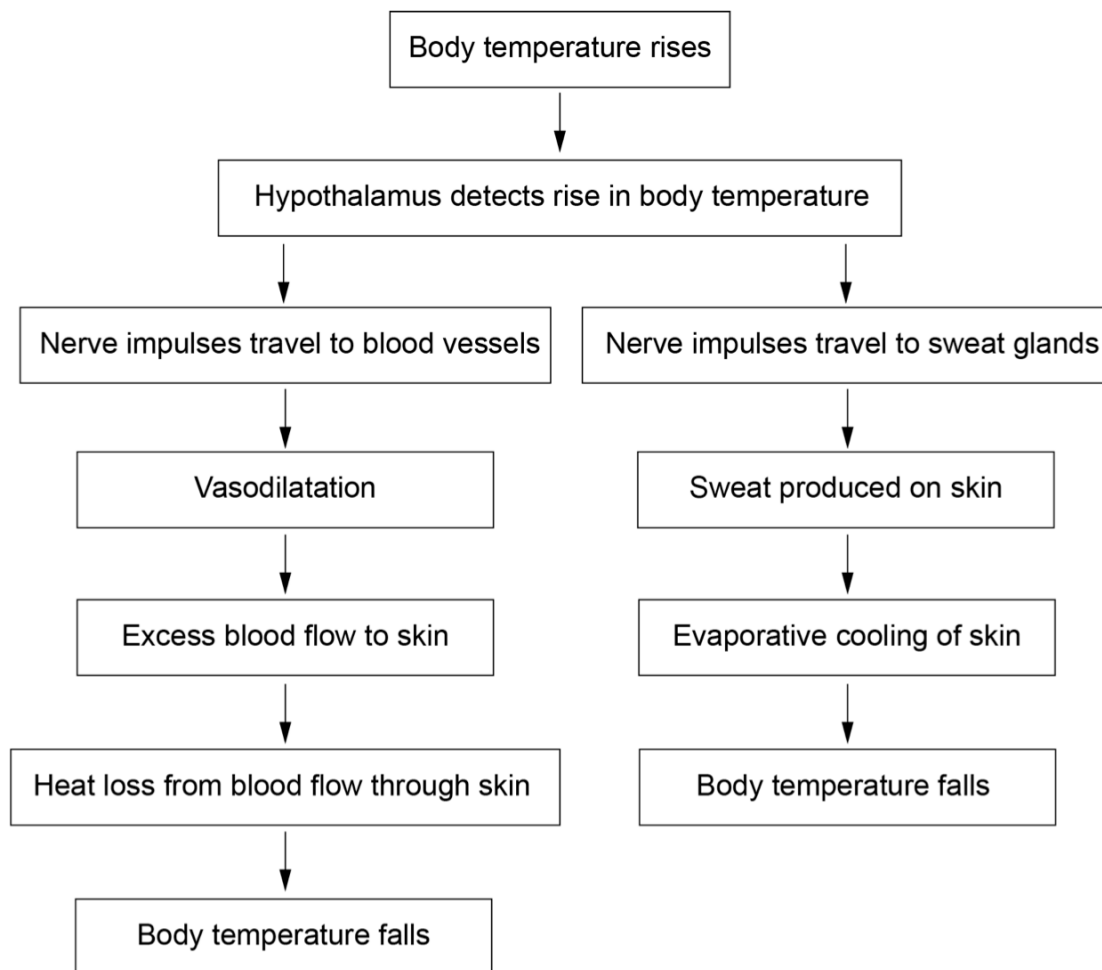
Section I

Multiple-choice Answer Key

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

Section II

Question 21

Criteria	Marks
• Completes all steps in the flow chart correctly	3
• Completes some steps in the flow chart to demonstrate a basic understanding of the reaction	2
• Provides some relevant information	1

Sample answer:

```
                        ┌─────────────────────┐
                        │ Body temperature rises │
                        └─────────────────────┘
                                  │
                                  ▼
              ┌──────────────────────────────────────────┐
              │ Hypothalamus detects rise in body temperature │
              └──────────────────────────────────────────┘
                    │                              │
                    ▼                              ▼
  ┌──────────────────────────────┐   ┌──────────────────────────────┐
  │ Nerve impulses travel to blood vessels │   │ Nerve impulses travel to sweat glands │
  └──────────────────────────────┘   └──────────────────────────────┘
                    │                              │
                    ▼                              ▼
        ┌──────────────────┐           ┌──────────────────────┐
        │  Vasodilatation  │           │ Sweat produced on skin │
        └──────────────────┘           └──────────────────────┘
                    │                              │
                    ▼                              ▼
        ┌──────────────────────┐       ┌──────────────────────────┐
        │ Excess blood flow to skin │       │ Evaporative cooling of skin │
        └──────────────────────┘       └──────────────────────────┘
                    │                              │
                    ▼                              ▼
  ┌──────────────────────────────┐       ┌──────────────────────┐
  │ Heat loss from blood flow through skin │       │ Body temperature falls │
  └──────────────────────────────┘       └──────────────────────┘
                    │
                    ▼
        ┌──────────────────────┐
        │ Body temperature falls │
        └──────────────────────┘
```

Question 22

Criteria	Marks
• Correctly completes table to show the differences between somatic and germ-line mutations	3
• Provides a substantially correct table to show the differences between somatic and germ-line mutations	2
• Provides some relevant information	1

Sample answer:

	Somatic mutation	*Germ-line mutation*
Location	Body cells (not gametes)	Sex cells/gametes only
Effect on offspring	Not passed to offspring	May be passed to offspring
Example	Mutation in skin cell DNA leading to Skin cancer	Mutation in sex cell leading to haemophilia

Question 23

Criteria	Marks
• Provides a thorough explanation of how educational programs reduce the incidence of non-infectious diseases • Supports answer with suitable examples	5
• Provides a sound explanation of how educational programs reduce the incidence of a non-infectious disease • Supports answer with suitable example(s)	4
• Provides some features of educational programs and links these to disease prevention • Provides a suitable example	3
• Provides some features or examples of educational programs that help prevent disease	2
• Provides some relevant information	1

Sample answer:

Name of disease: *Program to prevent disease:*
Melanoma   Slip, slop, slap, seek, slide
Lung Cancer   Quit (smoking)

Public education programs can raise awareness of the risk of exposure to various harmful environmental agents. For example UV radiation can cause melanoma and tobacco smoke increases the risk of lung cancer. As a result of the programs, people can alter their behaviour to reduce their exposure to harmful situations. For example not everyone can avoid the sun in their daily lives but the program encourages them to wear a hat, shirt and sunscreen so that exposure to UV radiation is reduced. This reduces the risk of melanoma.

Question 24

Criteria	Marks
• Demonstrates a thorough understanding of biodiversity • Demonstrates a thorough understanding of the relationship between the loss of biodiversity and each of two biotechnologies used in agriculture	5
• Demonstrates a sound understanding of biodiversity • Demonstrates a sound understanding of the relationship between the loss of biodiversity and each of two biotechnologies used in agriculture	4
• Describes a biotechnology used in agriculture and links it to the resultant loss of biodiversity OR • Outlines TWO biotechnologies used in agriculture and links them to loss of biodiversity	3
• Outlines a biotechnology used in agriculture and links this to biodiversity OR • Outlines TWO appropriate biotechnologies used in agriculture	2
• Provides some relevant information	1

Sample answer:

Biodiversity refers to the variety of species present in an ecosystem and also the genetic diversity of the species present.

Genetic Engineering has allowed modified corn such as Bt corn to be produced. Bt corn has a gene from ***Bacillus thuringiensis* (Bt)** incorporated into its genome. The Bt gene allows the corn to produce a toxin that kills caterpillars when they eat it, thus reducing the number of caterpillars present in the ecosystem. This may reduce the food available for species that feed on them, thus affecting food chains and food webs potentially reducing the number of species that can survive and therefore biodiversity. Bt corn may also reduce the biodiversity of the caterpillar population as susceptible varieties are killed and only those that are resistant survive to reproduce.

Artificial Insemination in agriculture involves collecting semen from desirable male animals such as bulls. Semen can be frozen, stored and transported to other locations and can be used to inseminate many females in order to produce multiple offspring with desirable traits. This results in a loss of biodiversity as one male has many offspring. All the offspring will be genetically half siblings so will have reduced genetic variation.

Question 25 (a)

Criteria	Marks
• Correctly identifies chromosomal mutation	1

Sample answer:

There is only one copy of the sex chromosome.

Question 25 (b)

Criteria	Marks
• Explains how meiosis can lead to the karyotype • Explains how fertilisation can lead to the karyotype	4
• Relates a problem during separation of chromosomes during meiosis to a lack of one chromosome in the offspring • Relates how fertilization can lead to a lack of one chromosome in the offspring	3
• Links a problem during cell division to the absence of a chromosome	2
• Provides some relevant information	1

Sample answer:

If homologous chromosomes in Meiosis I (or sister chromatids in Meiosis II) do not separate correctly, one gamete will end up with 2 copies of the same chromosome and another gamete will end up without a copy of this chromosome. After fertilisation, the gamete with no copy of sex chromosome has joined with a normal gamete to produce an individual with only one sex chromosome.

Question 26

Criteria	Marks
• Identifies variation in lactose tolerance with reference to stimulus • Provides reasons for the variation with detailed reference to evolution and DNA	5
• Identifies variation in lactose tolerance with reference to stimulus • Provides reasons for the variation with some reference to evolution and DNA	4
• Identifies variation in lactose tolerance with some reference to stimulus • Provides reason(s) for distribution of lactose tolerance with some reference to evolution OR DNA	3
• Identifies variation in lactose tolerance with some reference to stimulus • Provides a suitable reason for the distribution of lactose tolerance	2
• Provides some relevant information	1

Sample answer:

The map shows that ability to digest lactose varies in adult populations around the world. For example it is much lower in Australia than Northern Europe. This variation is likely to be due to natural selection where the presence of milk in the diet is the selective pressure. A mutation to a gene is likely to cause the continued production of lactase past the age of five years. Adults who possess the mutation are likely to have an increased chance of survival as they have increased nutrition in their diets. They then reproduce and pass the mutation on to their offspring, making it more common in the population. Populations that have remained largely lactose intolerant are less likely to have had milk available and thus a mutation of the lactase gene would not offer any advantage and would not become more common in the population.

Question 27 (a)

Criteria	Marks
• Identifies the type of reproduction	1

Sample answer:

Asexual reproduction

Question 27 (b)

Criteria	Marks
• Provides a suitable procedure which includes: – How the independent variable is changed – How the dependent variable is measured – Variables kept constant – Repetition – Logical sequence	4
• Outlines how the independent variable is changed • Outlines how the dependent variable is measured AND • Includes variables kept constant OR includes repetition	3
• Provides features of a relevant investigation	2
• Provides some relevant information	1

Sample answer:

1. Prepare a suspension of yeast cells.
2. Prepare water baths at three temperatures (15°C, 25°C and 35°C).
3. Mix the suspension.
4. Measure and place 5 mL of suspension into 9 test tubes.
5. Place three test tubes in each water bath.
6. Incubate for 2 hours and mix.
7. Take a drop from each test tube and place on a microscope slide with a coverslip.
8. Count the yeast cells using a mm grid on low power at each temperature and record the data.
9. Compare the number of cells recorded at each temperature.

Question 28 (a)

Criteria	Marks
• Suitable alleles identified for both parents	2
• Provides some relevant information	1

Sample answer:

Alleles from father
H, r

Alleles from mother
h, R

Question 28 (b)

Criteria	Marks
• Completes the diagram showing: – Genotype clearly modelled throughout – Alleles correctly modelled – Crossing over correctly modelled – Suitable key provided	4
• Provides a substantially correct model	3
• Provides some correct features	2
• Provides some relevant information	1

Sample answer:

Question 29

Criteria	Marks
• Describes a mechanism by which plants detect and respond to internal water levels to maintain homeostasis	3
• Outlines features of a mechanism by which plants maintain water balance	2
• Provides some relevant information	1

Sample answer:

Plants can control movement of water out of the leaf to keep a stable internal environment with respect to water, by altering the size of the opening of the stomates. The opening and closing is under hormonal control, for example abscisic acid is a stress hormone produced by plants when internal water is low, causing stomata to close thus reducing water loss.

Question 30

Criteria	Marks
• Explains frequency ratios • Draws suitable Punnett squares for each trait • Links Punnett squares to frequency ratio and type of inheritance • Provides a suitable key	5
• Identifies frequency ratios • Draws suitable Punnett squares for each trait • Provides a suitable key • Indicates both types of inheritance correctly	4
• Identifies frequency ratio(s) • Draws a suitable Punnett square • Indicates one type of inheritance correctly	3
• Demonstrates understanding of a mode(s) of inheritance	2
• Provides some relevant information	1

Sample answer:

Graph *A* shows a ratio of 3:1 of the two phenotypes. This is typical of dominant/recessive alleles.

The pure breeding parents must have been homozygous for seed shape eg RR for round and rr for wrinkled. The first generation would all have been round heterozygous Rr. When this generation was self-pollinated to provide the second generation the following Punnet square can be produced.

	R	r
R	RR	Rr
r	Rr	rr

KEY:

R = Round seed

r = Wrinkled seed

Graph *B* shows a ratio of 1:2:1 for the three phenotypes. This is typical of co-dominant alleles.

Neither allele is dominant and both are expressed. In the F1 generation, the chickens express both alleles and are heterogeneous. When they breed together the following Punnett square is produced.

	F^B	F^W
F^B	$F^B F^B$	$F^B F^W$
F^W	$F^B F^W$	$F^W F^W$

KEY:

F^B = Black feathers

F^W = White feathers

This results in 50% with black and white feathers, 25% black feathers and 25% white feathers.

Answers could include:

Incomplete dominance for Graph B where both alleles are blended.

Question 31 (a)

Criteria	Marks
• Outlines one adaptation that facilitates entry of a specific pathogen into its host	2
• Provides some relevant information	1

Sample answer:

The bacterium *Helicobacter pylori* causes stomach ulcers in humans. It has a flagellum that allows it to move and penetrate the mucus lining/barrier of the stomach wall.

Question 31 (b)

Criteria	Marks
• Explains how the mode of transmission of pathogens affects the spread of diseases	3
• Outlines how one mode of transmission of a pathogen affects the spread a disease OR • Identifies modes of transmission of pathogens	2
• Provides some relevant information	1

Sample answer:

Some diseases are spread easily by the pathogen passing between people in droplets in the air, eg influenza virus, and therefore the rates of infection are high in populated areas.

If an intermediate host or a vector is required then the spread of the disease may be slower depending on the presence of the vector.

Question 32 (a)

Criteria	Marks
• Identifies relevant global trends in malaria and dengue fever, based on the data provided	3
• Identifies trends in the incidence of malaria and dengue fever	2
• Provides a relevant trend	1

Sample answer:

The distribution of dengue fever appears to have increased markedly since 1950. There are many more parts of the world such as South America and Africa that are now affected. The number of countries with reported cases of malaria has decreased significantly. However, there is a growing number of people at risk, but representing a smaller percentage of the global population.

Question 32 (b)

Criteria	Marks
• Provides a thorough analysis of factors that could have affected the global distribution over time of both malaria and dengue fever • Relates analysis to data provided	7
• Provides a sound analysis of factors that could have affected the global distribution over time of both malaria and dengue fever • Refers to data provided	6
• Explains factors that could have affected global distribution over time of malaria and/or dengue fever • Refers to data provided	4–5
• Outlines factors that could have affected the distribution of malaria and/or dengue fever	2–3
• Provides some relevant information	1

Sample answer:

The global distribution of both dengue fever and malaria is likely to be associated with mosquito vectors. Airline travel has increased markedly over the last century offering opportunities for both infected people and the mosquito vectors to be transported around the world. In addition, world population has increased as shown in the table, which will increase the density of potential hosts of both diseases. With increasing urbanisation of a larger population, new urban habitats for the mosquitoes could have emerged. It could be argued that these factors have led to the increased distribution of dengue fever and the increased population at risk of malaria, but the number of countries, ie the distribution of malaria, has shrunk. This suggests that the mosquito vector for malaria has been contained within known areas. This could have been achieved by the use of pesticide spraying on water bodies to kill the mosquitoes, or by strict quarantine regulations whereby mosquitoes are eliminated before they can establish populations in new areas. To prevent spread of these diseases both the vector and the hosts need to be contained if possible.

Medical advances have the capacity to prevent or control these diseases, for example development of vaccines, especially for a viral disease such as dengue fever. From the data it would seem that medicines have had a greater effect in containing malaria than dengue fever. It may be that application of a vaccine in remote areas can limit the spread as the higher the proportion of the population vaccinated, the more effective the control of the disease. Also, antiviral drugs may assist in treatment of the disease. However, the evidence suggests that there are no suitable vaccines or drugs for dengue fever or that these have not been widely applied. It is possible too that the virus evolves quickly, rendering vaccines ineffective after a short period of time. Vaccines and pharmaceuticals, such as antibiotics and antimalarial drugs, appear to have been more effective for malaria than for dengue fever.

Question 33 (a)

Criteria	Marks
• Outlines processes of transcription AND translation	3
• Provides features of transcription AND/OR translation	2
• Provides some relevant information	1

Sample answer:

The DNA is unzipped and a complementary mRNA strand is transcribed. The mRNA moves to the ribosomes where translation occurs. Each codon is matched to a tRNA molecule with a complementary anticodon and carries a specific amino acid. The amino acids are joined together to form a polypeptide/protein.

Question 33 (b) (i)

Criteria	Marks
• Provides a suitable definition	2
• Provides some relevant information	1

Sample answer:

Alleles are different versions of a gene. 'Multiple alleles' refers to three or more versions of a gene existing in a population.

Question 33 (b) (ii)

Criteria	Marks
• Analyses the data to provide relevant conclusions about the risk associated with the alleles and combinations of alleles	4
• Analyses the data to provide suitable conclusions about the risk associated with the alleles	3
• Outlines risks associated with alleles	2
• Provides some relevant information	1

Sample answer:

The presence of e2 reduces the risk of AD. When it is present in the homozygous genotype or heterozygous with e3 there is a 40% reduction in risk of AD. The e2 allele appears to mask the effect of the e3 allele (e2 is dominant over e3). When e2 is combined with e4 AD is 2.6 times more likely, suggesting that e2 cannot fully mask e4. If two e4 alleles are present the risk of AD is greatly increased and is 14.9 times more likely. This suggests that e2 reduces the risk of AD and that e4 significantly increases the risk of AD.

When the individual is homozygous for the e3 allele there is an average risk of AD. However when e3 and e4 are present together the presence of e3 appears to reduce the increased risk that is the result of the e4 allele (e3/e4 makes AD 3.2 times more likely).

Question 33 (c)

Criteria	Marks
• Describes trends in the data	3
• Outlines trends in the data	2
• Provides some relevant information	1

Sample answer:

Patients with untreated HSV infection have an increased risk of developing dementia each year compared to patients who are not infected or are treated. Both treated and untreated HSV infection groups show a sharp increase in the risk of dementia after 10 years, but the untreated HSV group increases to more than double the risk of the treated HSV group. The group that did not have HSV infection only has a very small increase in risk after 10 years.

Question 33 (d)

Criteria	Marks
• Demonstrates an extensive knowledge of infectious and non-infectious disease, including criteria for classification of disease • Supports the classification of AD with detailed and appropriate reference to information and data provided • Justifies a suitable judgement • Communicates logically and succinctly with precise biological terms	8
• Demonstrates a thorough knowledge of infectious and non-infectious disease, including criteria for classification of disease • Supports the classification of AD with appropriate reference to information and data provided • Justifies a suitable judgement • Communicates logically using biological terms	7
• Demonstrates a sound knowledge of infectious and non-infectious disease, including reference to criteria for classification of disease • Supports the classification of AD with some reference to information and data provided • Provides a suitable judgement • Communicates effectively using biological terms	5–6
• Demonstrates some knowledge of the infectious and/or non-infectious disease • Relates data to classification of AD	3–4
• Provides information about infectious or non-infectious disease and AD data OR • Relates data to classification of AD OR • Provides information about infectious and non-infectious disease	2
• Provides some relevant information	1

Sample answer:

Infectious diseases are caused by pathogens that can be passed from one person to another. A pathogen is established as a cause of disease using a rigorous set of criteria known as Koch's postulates.

The data from the study provides evidence for an association between untreated viral (HSV) infection and the increased risk of development of dementia. The data also shows that treating HSV patients with antiviral medication results in a much lower risk of dementia over the following years. This provides some evidence that the disease may be infectious – a result of infection with the virus *Herpes simplex*. A strength of the study was the large number of patients, the length of time of the study and the way the control group was matched to the HSV group. These factors add validity to the findings.

However, this does not prove that HSV actually causes dementia, as Koch's postulates would need to be fulfilled. Additionally the historical study obtained results about dementia, and not all of the dementia cases would have been Alzheimer's disease (although AD is the commonest cause of dementia). This reduces the validity of the findings in terms of establishing HSV as a cause of AD.

Non-infectious diseases do not spread from person to person and are not caused by pathogens. They are caused by other factors such as environmental factors or inherited genes.

AD is the result of the build up of amyloid protein. Protein synthesis is regulated by genes, suggesting the disease is non-infectious. The data about the APOE gene indicates that the presence of certain alleles, such as APOE-e4, result in a large increase in the risk of developing AD. It also appears that the presence of APOE-e2 allele reduces the risk of AD. This provides evidence for an inherited genetic basis for developing the disease, meaning that it could be classified as non-infectious. However, the development of AD may also be influenced by other genes and factors such as pathogens.

From the information provided it is not possible to classify Alzheimer's disease as infectious or non-infectious as there appears to be evidence that the risk of developing it is influenced by both a viral pathogen and genes.

2019 HSC Biology
Mapping Grid

Section I

Question	Marks	Content	Syllabus outcomes
1	1	Mod 7 Causes of Infectious Disease Mod 8 Cause and Responses	Bio12–14, Bio12–15
2	1	Mod 7 Prevention, Treatment and Control	Bio12–14
3	1	Mod 6 Mutation	Bio12–6, Bio12–13
4	1	Mod 5 Cell Replication	Bio12–6, Bio12–12
5	1	Mod 7 Immunity	Bio12–14
6	1	Mod 8 Technologies and Disorders	Bio12–15
7	1	Mod 7 Causes of Infectious Disease Mod 7 Prevention, Treatment and Control	Bio12–4, Bio12–5, Bio12–14
8	1	Mod 6 Genetic Technologies	Bio12–7, Bio12–4, Bio12–13
9	1	Mod 5 Reproduction	Bio12–12
10	1	Mod 7 Prevention, Treatment and Control	Bio12–2, Bio12–14
11	1	Mod 5 Genetic Variation	Bio12–12, Bio12–13
12	1	Mod 8 Homeostasis	Bio12–5, Bio12–15
13	1	Mod 6 Mutation	Bio12–13
14	1	Mod 5 DNA and Polypeptide Synthesis	Bio12–5, Bio12–12
15	1	Mod 6 Mutation	Bio12–13
16	1	Mod 7 Immunity Mod 7 Prevention, Treatment and Control	Bio12–5, Bio12–6, Bio12–14
17	1	Mod 5 Genetic Variation	Bio12–5, Bio12–12
18	1	Mod 5 Reproduction Mod 8 Homeostasis	Bio12–5, Bio12–6, Bio12–12, Bio12–15
19	1	Mod 6 Biotechnology Mod 6 Genetic Technologies	Bio12–5, Bio12–6, Bio12–13
20	1	Mod 6 Biotechnology Mod 6 Genetic Technologies	Bio12–5, Bio12–6, Bio12–13

Section II

Question	Marks	Content	Syllabus outcomes
21	3	Mod 8 Homeostasis	Bio12–4, Bio12–5, Bio12–7, Bio12–15
22	3	Mod 6 Mutation	Bio12–7, Bio12–13
23	5	Mod 8 Prevention	Bio12–15
24	5	Mod 6 Biotechnology Mod 6 Genetic Technologies	Bio12–7, Bio12–13
25 (a)	1	Mod 6 Mutation	Bio12–6, Bio12–13
25 (b)	4	Mod 6 Mutation	Bio12–13
26	5	Mod 6 Mutation	Bio12–5, Bio12–6, Bio12–7, Bio12–13

Question	Marks	Content	Syllabus outcomes
27 (a)	1	Mod 5 Reproduction	Bio12–12
27 (b)	4	Mod 5 Reproduction	Bio12–2, Bio12–12
28 (a)	2	Mod 5 Genetic Variation	Bio12–6, Bio12–12
28 (b)	4	Mod 5 Cell Replication Mod 5 Genetic Variation	Bio12–6, Bio12–7, Bio12–12
29	3	Mod 8 Homeostasis	Bio12–15
30	5	Mod 5 Genetic Variation	Bio12–5, Bio12–6, Bio12–7, Bio12–12
31 (a)	2	Mod 7 Causes of Infectious Disease	Bio12–14
31 (b)	3	Mod 7 Causes of Infectious Disease	Bio12–14
32 (a)	3	Mod 7 Prevention, Treatment and Control	Bio12–5, Bio12–6, Bio12–14
32 (b)	7	Mod 7 Prevention, Treatment and Control	Bio12–5, Bio12–6, Bio12–14
33 (a)	3	Mod 5 DNA and Polypeptide Synthesis	Bio12–12
33 (b) (i)	2	Mod 5 Genetic Variation	Bio12–12
33 (b) (ii)	4	Mod 8 Epidemiology	Bio12–5, Bio12–15
33 (c)	3	Mod 8 Epidemiology	Bio12–5, Bio12–15
33 (d)	8	Mod 7 Causes of Infectious Disease Mod 8 Causes and Effects Mod 8 Epidemiology	Bio12–5, Bio12–14, Bio12–15