



Student Number

Sydney Boys High School
HSC TRIAL EXAMINATION

Biology 2020

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- Write your Student Number at the top of this page and also on the multiple choice answer sheet

Total marks – 100

Part A Pages 2-10

20 marks

- Attempt Questions 1–20
- Allow about 35 minutes for this part

Part B Booklet 1 – page 11 - 18

Booklet 2 – pages 19 - 28

80 marks

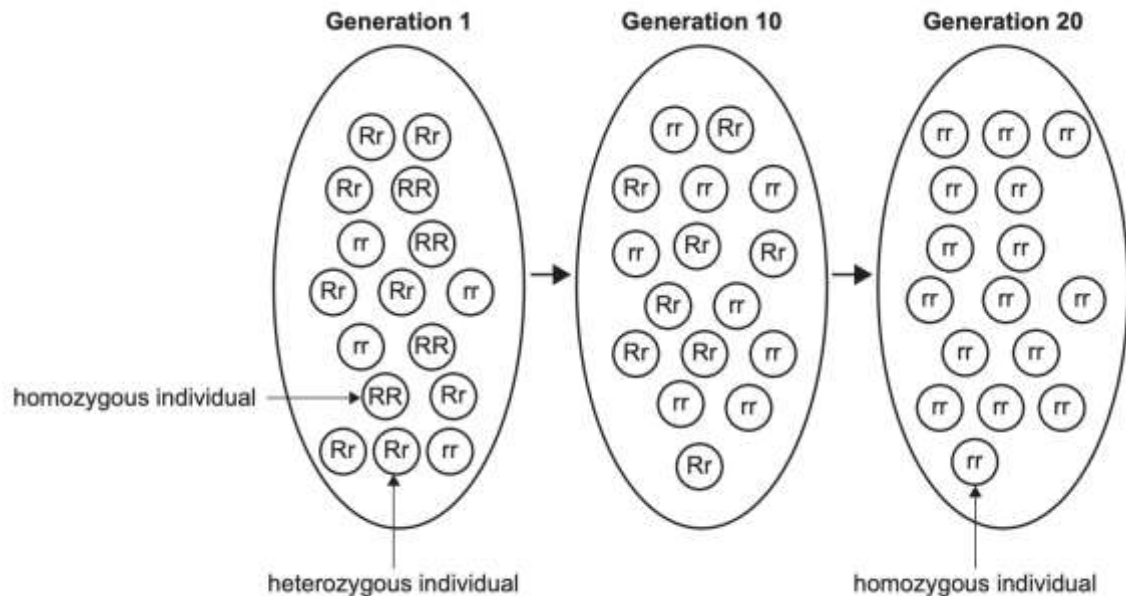
- Attempt Questions 21–34
- Allow about 2 hours and 25 minutes for this part

Part A – 20 marks

Attempt Questions 1 – 20

Use the multiple-choice answer sheet.

1. Consider the diagram below showing the gene pool of a population over 20 generations

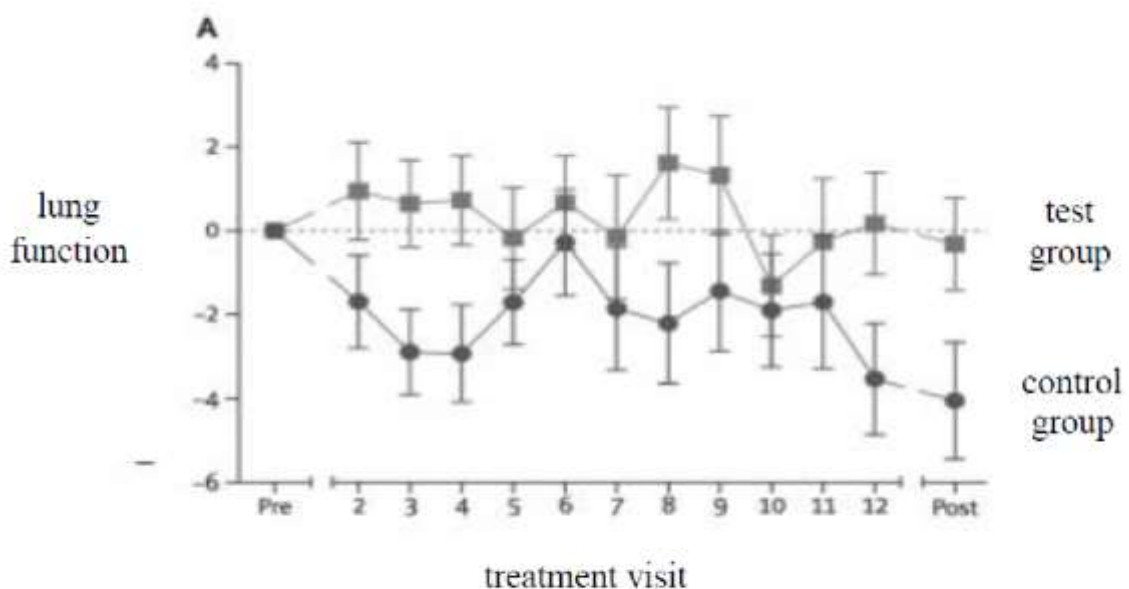


It would be correct to conclude that, over the 20 generations

- (A) genetic diversity is increasing in this population.
 - (B) individuals with the genotype RR had a selective advantage in this population.
 - (C) the frequency of each allele is equal in Generation 1 but not in other generations.
 - (D) new advantageous alleles for this gene were introduced as individuals joined this population.
2. Insulin is produced by the
- (A) Liver
 - (B) Pancreas
 - (C) Hypothalamus
 - (D) Posterior pituitary gland
3. A potential pathogen was found to be heterotrophic and have a cell wall and membrane bound organelles.
It should be classified as a:
- (A) prion
 - (B) bacterium
 - (C) protozoan
 - (D) fungus

4. The graph shows the results of a study on the effectiveness of a type of gene therapy on sufferers of cystic fibrosis, an inherited disease which impairs lung function. 150 sufferers were separated into two groups, a test group and a control group. Patients did not know which group they were in. The test group received the treatment and the control group were treated with a placebo (a treatment which doesn't contain the gene). Changes in the average lung function of each group are shown in the graph below.

Zero on the Y axis represents the lung function at the start of the study and the points on the graph show how lung function (expressed as a %) then varied from this initial level as the study proceeded.



Adapted from Alton et al. 2015. The Lancet.

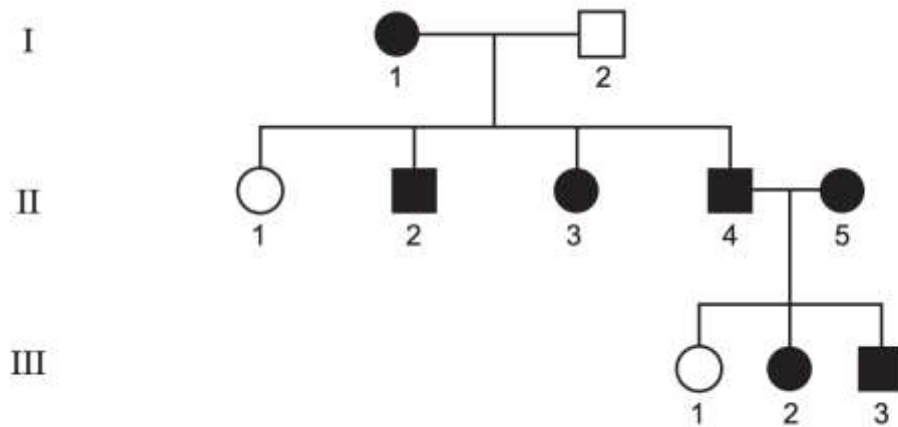
Which one of the following is a valid inference from this graph?

- (A) The treatment did not produce a lasting improvement in lung function.
- (B) The placebo was more effective than the treatment.
- (C) There was no difference in the effectiveness of the two treatments.
- (D) The treatment produced a lasting improvement in lung function.

5. Which defence adaptation in the table is correctly matched with one of its features?

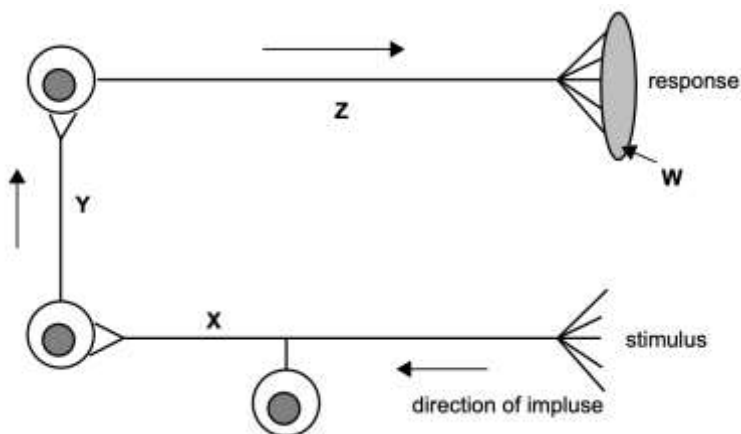
Defence adaptation	Feature
(A) Inflammation	Constriction of blood vessels
(B) Lymph system	Transportation of blood to help fight pathogens
(C) Cell death	Formation of a barrier around the pathogen
(D) Complement cascade	Production of antibodies by white blood cells

6. Familial atrial fibrillation is an autosomal condition in which individuals have an altered heart rhythm. Shaded individuals in the following pedigree have this condition.



From this information, it would be correct to conclude that

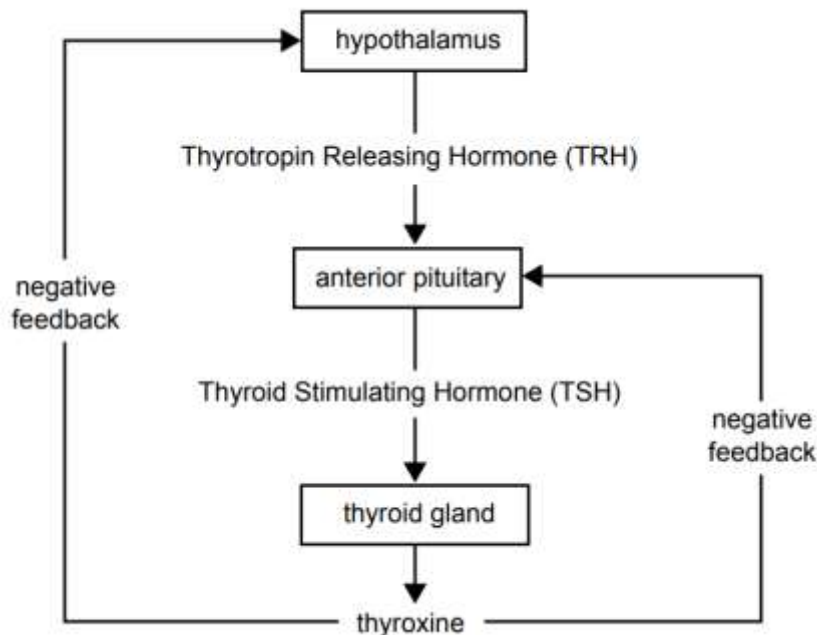
- (A) individual I-1 must be homozygous.
 (B) individual II-1 must be heterozygous.
 (C) individual II-3 must be heterozygous.
 (D) individual III-2 must be homozygous.
7. An electrical impulse can be transmitted along three neurons as shown in the following diagram.



Which of the following correctly identifies W, X, Y and Z?

	W	X	Y	Z
(A)	effector	sensory neuron	interneuron	effector neuron
(B)	effector	interneuron	sensory neuron	effector neuron
(C)	effector neuron	sensory neuron	interneuron	effector
(D)	effector neuron	interneuron	sensory neuron	effector

8. The following diagram shows the regulation of thyroxine secretion



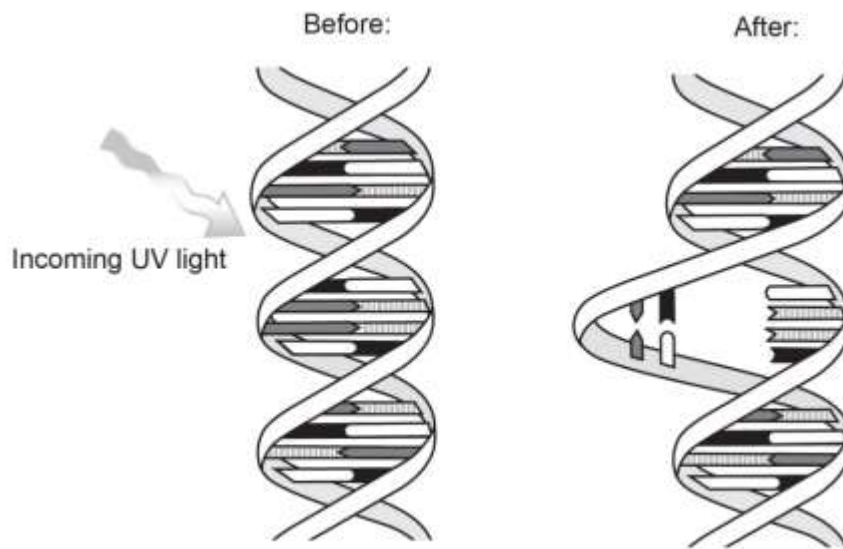
A person who lacks sufficient iodine in the diet is unable to manufacture thyroxine. This is because iodine is required by the thyroid gland to manufacture thyroxine. It is reasonable to conclude that when a person lacks sufficient iodine in the diet

- (A) TSH production would increase.
- (B) TRH production would decrease.
- (C) the negative feedbacks would cease to operate.
- (D) the metabolic rate of cells in the body would increase.

9. Why is Polymerase Chain Reaction (PCR) used in biotechnology?

- (A) produces large numbers of copies of target DNA, which increases the chances of success of biotechnology applications.
- (B) allows researchers to easily alter DNA sequences and modify gene function
- (C) allows the direct uptake exogenous genetic material from its surroundings through the cell membrane
- (D) catalyses formation of a phosphodiester bond between nucleotides

10. The following diagram shows the structure of a DNA molecule before and after exposure to ultraviolet (UV) light.

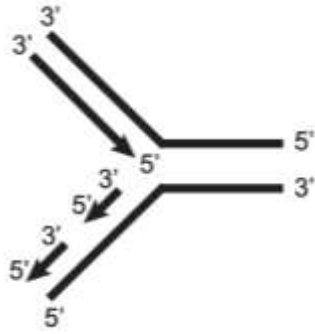


What effect does UV light have on the DNA structure?

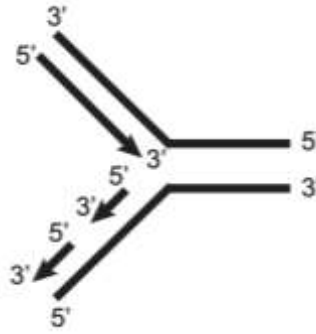
- (A) It breaks hydrogen bonds between bases, these free bases then form dimers
 - (B) Releases electrons from atoms and molecules generating ions which break phosphodiester bonds in the DNA strand.
 - (C) Impacts the DNA directly, causing ionization of the atoms in the DNA molecule. This results in a single stranded break.
 - (D) Modifies the nitrogenous bases. For example changes cytosine to uracil.
11. Several responses of the immune system result in the perforation of specific cells and subsequent rupture of the cells due to the inflow of extracellular fluid. This process can be directly caused by:
- (A) both T-cells and B-cells
 - (B) mast cell activity
 - (C) B-cells and mast cells
 - (D) complement action

12. The structure of a DNA replication fork is best represented by

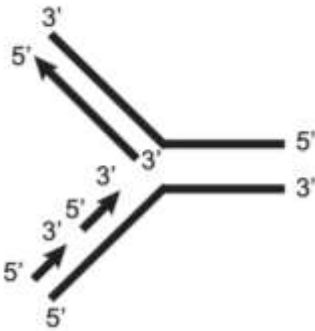
(A)



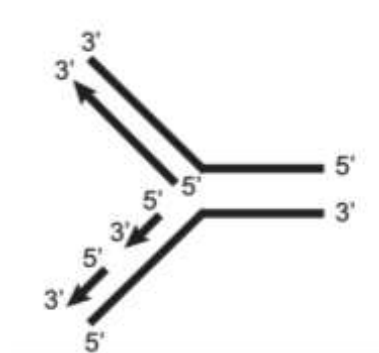
(B)



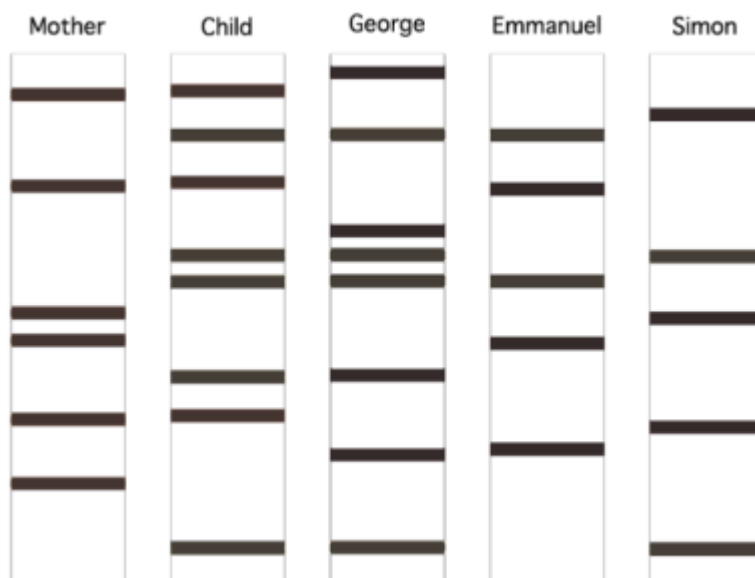
(C)



(D)



13. DNA profiling can be used to test for paternity. Three men (George, Emmanuel and Simon) were tested to determine the paternity of a child and the following banding patterns were produced



Which individual could you conclude is the most likely to be the father from these data?

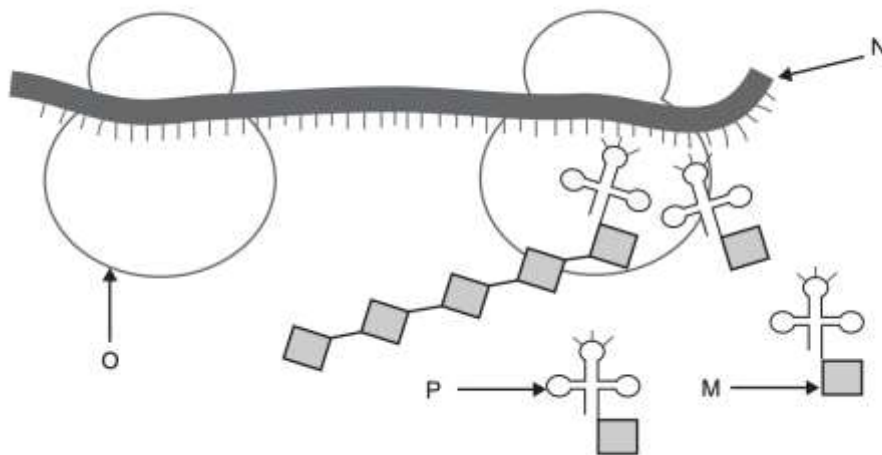
(A) George

(B) Emmanuel

(C) Simon

(D) None of the three men, as none of their profiles exactly matches that of the child.

14. Translation of the genetic code occurs in the cytosol of a cell. The following diagram is one representation of translation.

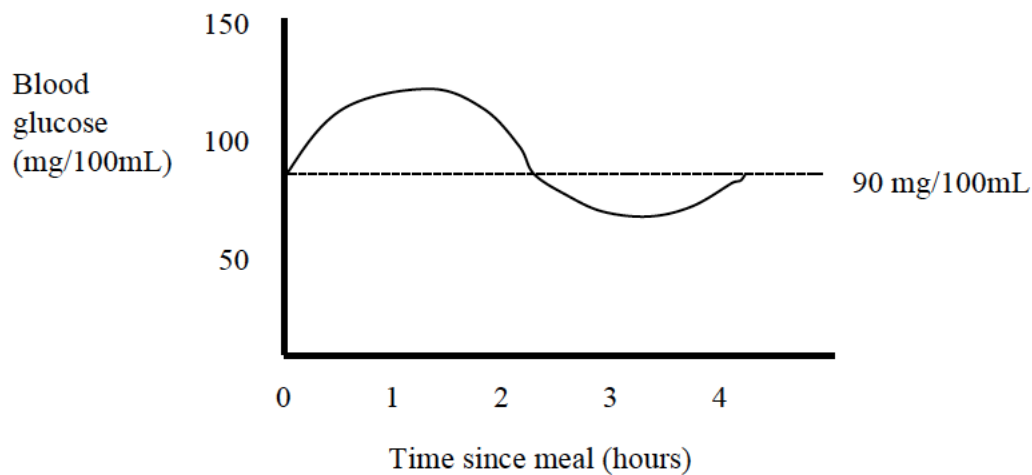


In the model presented

- (A) N represents a ribosome.
- (B) P represents messenger RNA.
- (C) O represents transfer RNA.
- (D) M represents an amino acid.

Questions 15 and 16 refer to the graph below.

Blood glucose levels are regulated by the hormones insulin and glucagon.



15. What stimulates a release of glucagon?
- (A) An increase of blood glucose above 90 mg/100mL
 - (B) An increase of blood glucose above 125 mg/100mL
 - (C) An decrease of blood glucose above 90 mg/100mL
 - (D) An decrease of blood glucose above 75 mg/100mL

16. Type II diabetes develops when the cells of the body start to lose their sensitivity to insulin. Which one of the following symptoms would result from this?
- (A) Blood glucose levels would fall.
- (B) Blood glucose levels would rise.
- (C) Glucose levels rise in body cells.
- (D) Glycogen levels rise in body cells.

Use the following information to answer Questions 17 and 18

		Second letter				
		U	C	A	G	
First letter	U	UUU } phe UUC } UUA } leu UUG }	UCU } UCC } ser UCA } UCG }	UAU } tyr UAC } UAA STOP UAG STOP	UGU } cys UGC } UGA STOP UGG trp	U C A G
	C	CUU } CUC } leu CUA } CUG }	CCU } CCC } pro CCA } CCG }	CAU } his CAC } CAA } gln CAG }	CGU } CGC } arg CGA } CGG }	U C A G
	A	AUU } AUC } ile AUA } AUG met	ACU } ACC } thr ACA } ACG }	AAU } asn AAC } AAA } lys AAG }	AGU } ser AGC } AGA } arg AGG }	U C A G
	G	GUU } GUC } val GUA } GUG }	GCU } GCC } ala GCA } GCG }	GAU } asp GAC } GAA } glu GAG }	GGU } GGC } gly GGA } GGG }	U C A G

Consider the following sequence of six amino acids that make up part of a polypeptide.

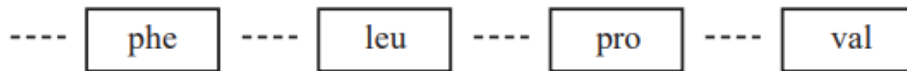
---- [phe] ---- [leu] ---- [pro] ---- [val] ---- [tyr] ---- [ala] ----

A mutation within the gene coding for this sequence of six amino acids resulted in the following six amino acids in the same position.

---- [phe] ---- [leu] ---- [ala] ---- [val] ---- [tyr] ---- [ala] ----

17. This change in the sequence of amino acids was caused by
- (A) a deletion of a nucleotide.
- (B) an insertion of a nucleotide.
- (C) a substitution of a nucleotide.
- (D) an inversion of adjacent nucleotides.

18. Another mutation within the original gene resulted in a shortened protein. The protein was truncated (cut short) after the amino acid valine, as shown below.



This truncated protein resulted from the codon

- (A) UAU changing to UAA.
 - (B) UAC changing to UGC.
 - (C) GUA changing to UGA.
 - (D) GUG changing to UGG
19. Which best describes a single nucleotide polymorphism
- (A) a single base change in the base sequence of a section of DNA in at least 1% of the population
 - (B) a single base mutation
 - (C) a mutation which deletes an allele
 - (D) a mutation which results in a repeat of a single nucleotide
20. Reproductive technologies focus on transfer of genetic information
- Which reproductive technology involves the process of cell enucleation?
- (A) Artificial insemination
 - (B) Artificial pollination
 - (C) Cloning
 - (D) In vitro fertilisation

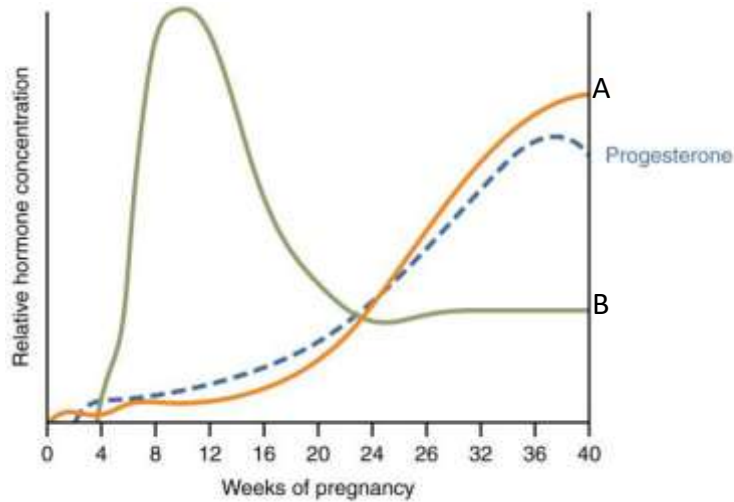
Part B

Answer the questions in the spaces provided.

Marks

Question 21 (3 marks)

The graph below shows how the level of three hormones change during human pregnancy.



Betts et al. (2013) *Anatomy & Physiology*

Retrieved from <https://openstax.org/books/anatomy-and-physiology/pages/28-4-maternal-changes-during-pregnancy-labor-and-birth>

(a) Identify the hormones labelled A & B.

1

(b) Describe how one of the hormones is involved in the control of pregnancy.

2

Question 22 (5 marks)

The Mallee Emu-wren (*Stipiturus mallee*) is an endangered species of small bird living in semiarid shrublands in south-eastern Australia. Bushfires occur frequently in this area and may have reduced the population of this species.

Refer to the following map, the shaded area shows the distribution of the Mallee Emu-wren:



- (a) Describe how a change in the gene pool of the Mallee Emu-wren may result in genetic drift.

3

- (b) Describe a possible consequence of genetic drift for the Mallee Emu-wren population.

2

Question 23 (7 marks)

- (a) Using examples, describe two different ways by which infectious diseases can be transmitted. For each example, include the name of the disease, the causative agent and the mode of transmission.

- (b) For one of the diseases described in (a), explain how specific adaptations of the pathogen responsible facilitate the transmission of the disease between hosts.

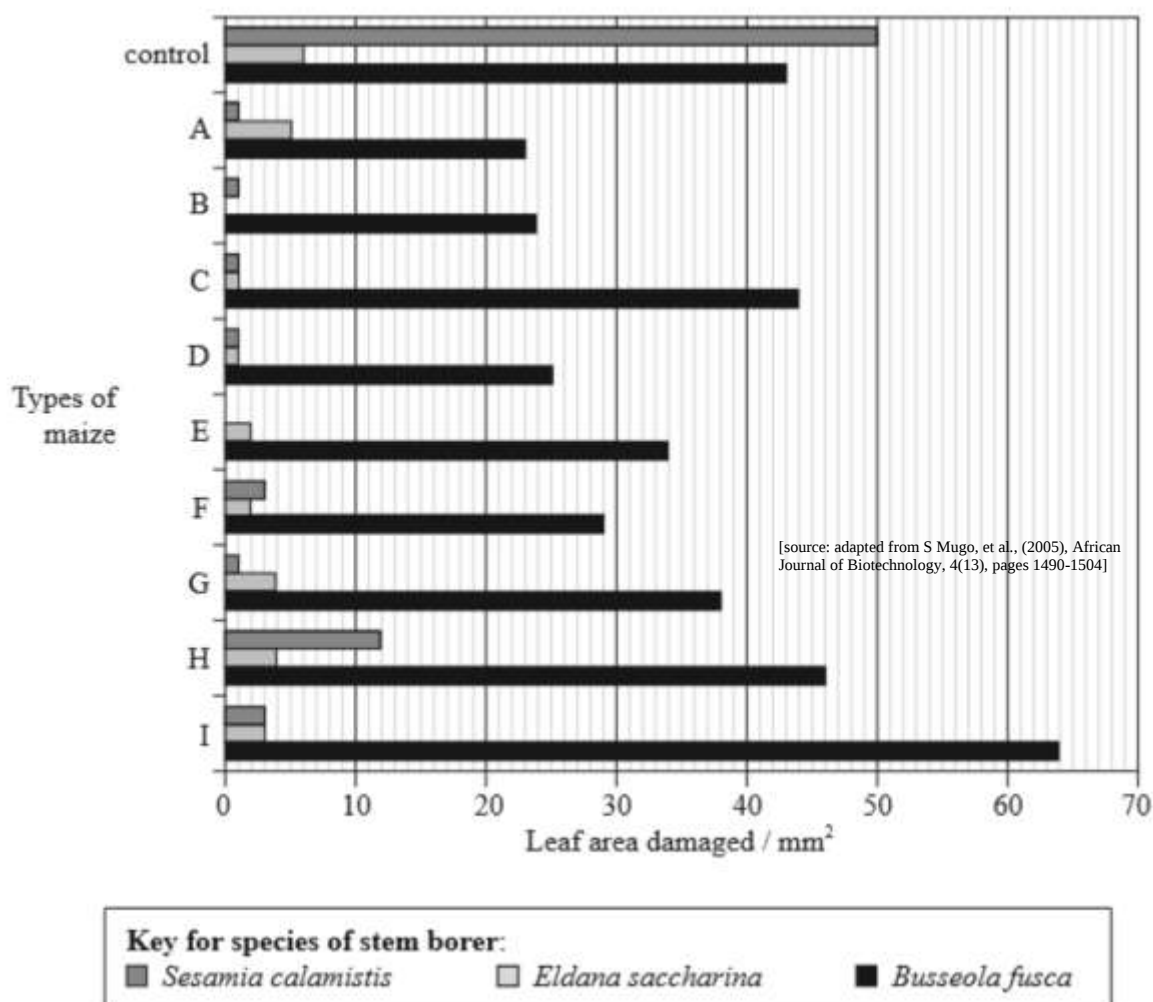
2

- (c) For one of the diseases described in (a), outline two procedures that can be employed to prevent the spread of the disease.

2

Question 24 (8 marks)

Genetic engineering allows genes for resistance to pest organisms to be inserted into various crop plants. Bacteria such as *Bacillus thuringiensis* (BT) produce proteins that are highly toxic to specific pests. Stem borers are insects that cause damage to maize crops. In Kenya, a study was carried out to see which types of BT genes and their protein products would be most effective against three species of stem borer. The stem borers were allowed to feed on nine types of maize (A-I), modified with BT genes. The graph below shows the leaf areas damaged by the stem borers after feeding on maize leaves for five days.



(a) Identify what would be used as a control in this experiment.

1

Question 24 continues on page 15

Question 24 (continued)

(b) Evaluate the effectiveness of the types of Bt maize studied, in controlling the three species of stem borers.

4

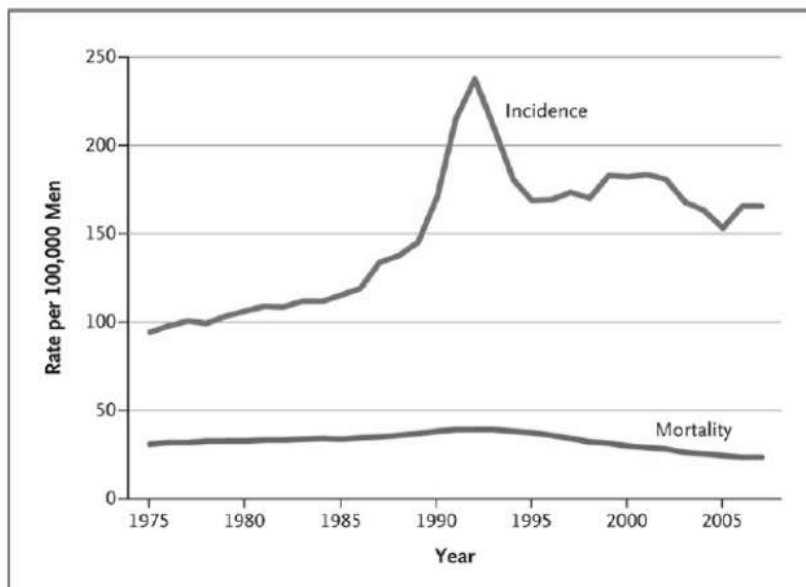
(c) Explain the loss of biodiversity that may result from using Bt maize in agriculture.

3

Question 25 (13 marks)

Prostate cancer is the most commonly diagnosed cancer in Australian men. Most prostate cancers are first found as a result of screening with a prostate-specific antigen (PSA) blood test or a digital rectal exam (DRE).

The graph below is taken from the New England Journal of Medicine.



Prichard et al N Engl J Med 2016;
375:443-453
DOI: 10.1056/NEJMoa1603144

- (a) Analyse the data presented here on the incidence and mortality of prostate cancer.

5

Question 25 continues on page 17

Question 25 (continued)

3

(b) Germline variants in DNA repair genes have been shown to be associated with the aggressive form of prostate cancer.
Explain how mutations of DNA repair genes, or genes which control the cell cycle, might cause cancer.

5

(c) It has also been suggested that a diet rich in meat is a cause of prostate cancer.
Design an epidemiological study which could be used to test this hypothesis.

Question 26 (4 marks)

Explain how the contributions of Louis Pasteur and Robert Koch have increased our understanding of the cause and transmission of infectious disease

Answer Question 27-34 in Booklet 2



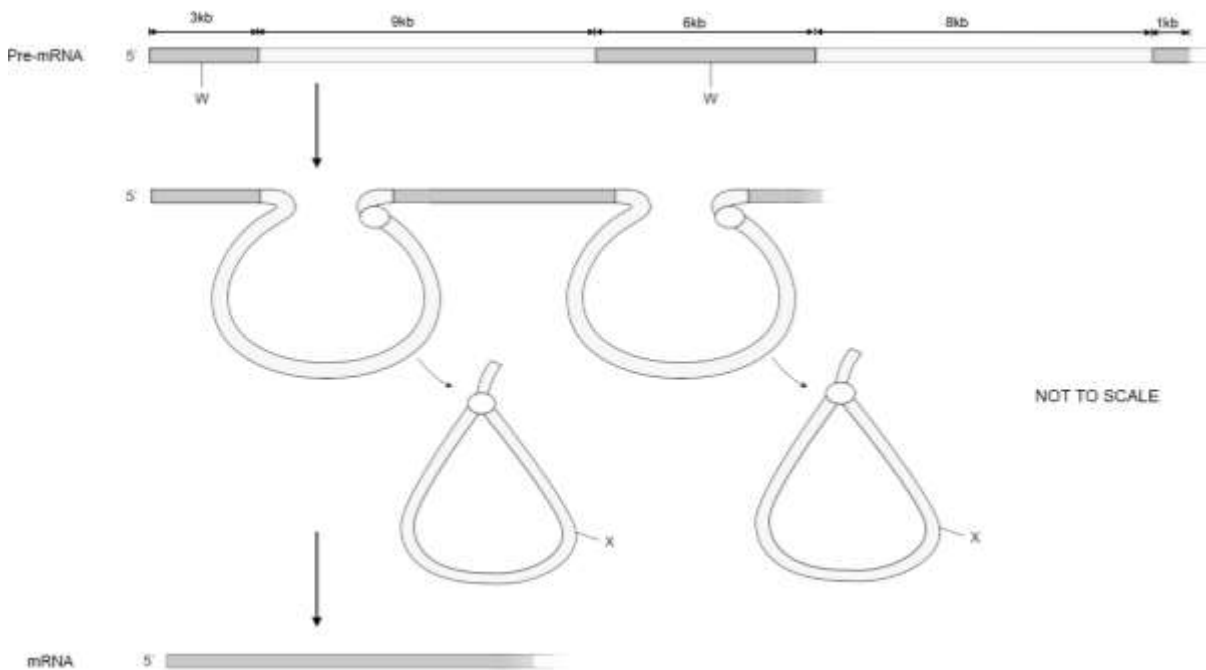
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Biology 2020 – Booklet 2

Question 27 (4 marks)

The diagram below illustrates a process that occurs in eukaryote cells.



- (a) Identify the regions labelled W and X and explain the benefit and the role this process plays in eukaryotic cells.

4

Question 28 (4 marks)

A student carried out an investigation to identify the presence of microbes in water from different sources.

The student obtained 3 petri dishes containing sterilised nutrient agar and inoculated them with a sample of either tap water, bottled water or tank water.

The table below summarises the procedure and results.

Water source	Incubation temperature (°C)	Estimated % cover of bacterial colonies
Tap water	37	30
Bottle water	37	5
Tank water	37	90

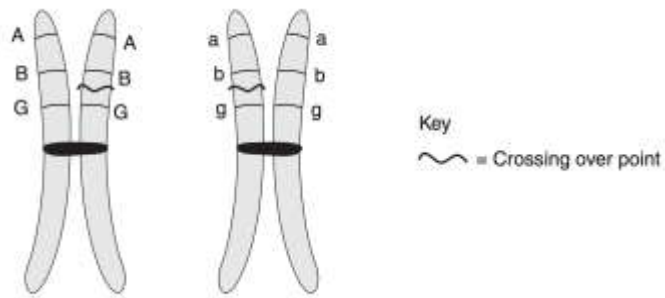
(a) Identify the independent and dependent variable. 1

(b) Outline how ONE safe work practice could minimize a risk associated with working with microbes 1

(c) Was the investigation valid? Justify your response. 2

Question 29 (5 marks)

Three genes are arranged along a homologous pair of chromosomes as shown.



(a) Label, on the diagram below, the alleles after crossing over has occurred

1



(b) Explain the effect of independent assortment of chromosomes on the genotype of the offspring

2

(c) Describe how two types of mutations that can result from errors that occur during meiosis.

2

Question 30 (3 marks)

Describe a plant disease of agricultural significance, including the symptoms resulting from infection and what processes have been used to prevent or control it.

Question 31 (4 marks)

Discuss how xerophytes minimises water loss while still allowing for gas exchange.

Question 32 (9 marks)

Neural tube defects (NTD) are major congenital anomalies that result from very early disruption in the development of the brain and spinal cord.

Since the 1960s there has been mounting evidence of a decreased prevalence of NTD with increased intake of folic acid during the period around conception. Folic acid and folate are forms of Vitamin B. Folic acid and folate occur naturally in food; folic acid may be added to some foods and can also be taken as a supplement.

Folate is necessary for the production and maintenance of new cells, which is especially important during periods of rapid cell division and growth such as infancy and pregnancy.

In 1992 Australian governments began education programs to actively promote folic acid intake prior to pregnancy to try and reduce the prevalence of NTD.

Mandatory folic acid fortification of all flour used for making bread (except organic bread) came into effect in September 2009.

The following data provide information about the prevalence of NTD in Western Australia.

**Prevalence rate of NTD diagnosed among births and TOP
in Western Australia 1992-2014**

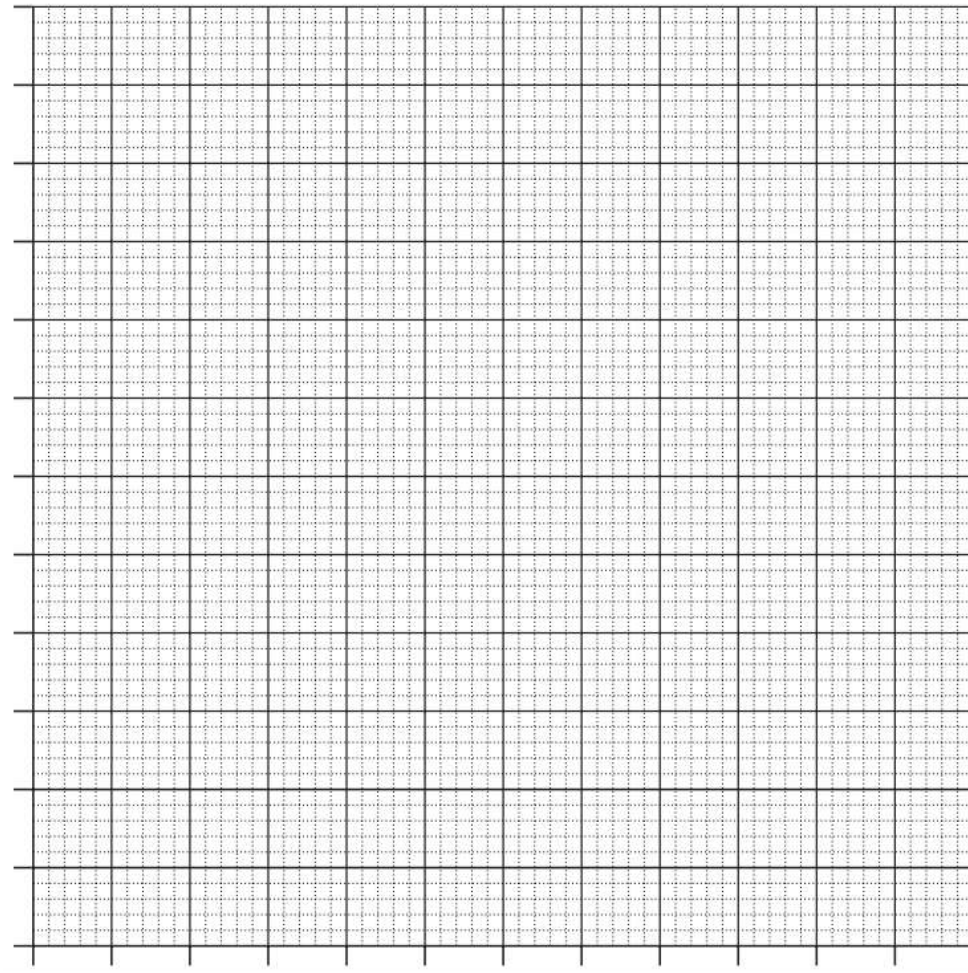
Year	Rate per 10 000
1992	19.3
1993	17.8
1994	21.6
1995	24.8
1996	14.1
1997	13.9
1998	13.6
1999	16.7
2000	16.6
2001	14
2002	13.7
2003	10.5
2004	17.6
2005	16.3
2006	15
2007	13.7
2008	13.5
2009	14.6
2010	11.9
2011	13.8
2012	10.7
2013	11.8
2014	11.8

Question 32 continues on page 25

Question 32 continued

(a) Draw the most appropriate graph for the information, on the grid provided.

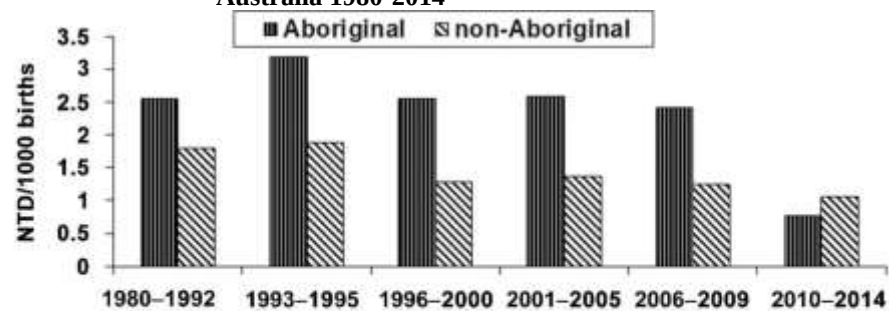
3



(b) Identify a trend shown in the data.

2

Neural tube defects in Aboriginal and non-Aboriginal infants by grouped years of birth, Western Australia 1980-2014



Data from the WA Register of Developmental Anomalies
 1980-1995 baseline
 1996-2009 health promotion; voluntary fortification
 2010+ mandatory fortification

Year of birth

Question 32 continued

4

- (c) With reference to the prevention strategies and the data provided account for the differences between Aboriginal and non-Aboriginal NTD prevalence.

[illegible]

Question 33 (3 marks)

3

Use a table to compare the effectiveness of antivirals and antibiotics in the treatment of diseases. Q

Question 34 (8 marks)

Vaccines have traditionally used live attenuated or inactivated pathogens to induce an immune response.

Gene vaccines are a new approach to immunization in which, rather than a live attenuated or inactivated organism (or a subunit thereof), one or more genes that encode for the antigens of the pathogen are delivered into the organism via a plasmid. Explain how this approach would generate immunity against diseases?

[illegible]

[illegible]

END OF EXAM

Multiple Choice

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

Question 21 a

Criteria	Marks
Correctly identifies both hormones	1

A = Oestrogen

B = hCG/relaxin

Question 21 b

Criteria	Marks
Describes how the hormone is involved in the control of pregnancy	2
Briefly describes how the hormone is involved in the control of pregnancy	1

Human chorionic gonadotropin (hCG)

hCG is an important hormone in early pregnancy. It's produced by the placenta after implantation and supports the function of the corpus luteum. The corpus luteum is a temporary structure in the ovaries which produces other key hormones during early pregnancy.

Progesterone

During the early weeks of pregnancy, the corpus luteum produces progesterone. After 8-12 weeks, the placenta takes over.

Progesterone stimulates growth of the blood vessels that supply the womb lining. It also stimulates the lining to release nutrients, providing nourishment for the early embryo.

Additionally, progesterone inhibits contraction of the smooth muscle of the uterus so that it grows as the baby does.

Question 22a

Criteria	Marks
Define genetic drift as the change in allele frequency due to chance. Describe possible changes to the gene pool with reference to the map. Link genetic drift/bottleneck/chance even to the fires.	3

Genetic drift is the change in allele frequency due to chance.

Bottleneck effect is a severe reduction in genetic diversity due to a catastrophe that may change allele frequency. From the map it has led to small populations in which remaining individuals may not be an accurate representation of the allele frequency of the original population.

The fires have killed many of the population by chance. This is the bottleneck effect. The fires killed many of the Mallee Emu-wren population. The Mallee Emu-wren that have survived is purely due to chance, not because they have favourable characteristics.

Question 22 (b)

Criteria	Marks
Describes a possible consequence of genetic drift	2

Genetic drift is the random process by which alleles can be lost from a population. It is particularly important in small populations. This results in a reduction of the gene pool and hence the genetic diversity of a population. When genetic diversity in a species with few individuals gets below a certain level it is very hard for the species to survive as it lacks the genetic variation to adapt to environmental changes or survive diseases.

Question 23 (a)

Criteria	Marks
Correctly describes two different ways that infectious diseases can be transmitted each with an appropriate example including: - Name of the disease - Causative agent - Mode of transmission (total of 6 points for two diseases)	3
- 4-5 points	2
- 2-3 points	1
- 1 point	0

Sample answer:

Diseases may be transmitted by ingestion of infected water, inhalation of suspended droplets and by direct transfer of bodily fluids.

Cholera is caused by a bacterium that is transmitted from one person to another through drinking water.

Influenza is caused by a virus and is transmitted when a person inhales suspended droplets that have been coughed out by an infected individual.

AIDS is caused by the human immunodeficiency virus (HIV) and is transmitted from one person to another by direct transfer of bodily fluids, such as blood or semen. This can occur

Question 23 (b)

Criteria	Marks
• Describes at least two adaptations of the named pathogen that facilitate the transmission of the disease between hosts	2
• Describes one adaptation of the named pathogen that facilitates the transmission of the disease between hosts	1

Sample answer:

Influenza viruses can survive and remain suspended in the air for long periods and as they are noncellular, they can resist harsh environmental conditions such as drying out and low oxygen availability. The virus causes the infected individual to cough and sneeze, which facilitates the transmission from one host to another.

Question 23 (c)

Criteria	Marks
• Outlines 2 RELEVANT procedures	1

- **Social distancing**
- **Masks**
- **Quarantine/isolation**

Question 24(a)

Criteria	Marks
Identifies the control as maize that did not have a BT gene added	1

Maize not transformed with Bt (genes)

Question 24 (b)

Criteria	Marks
- Make a judgement on whether the Bt maize types are effective at controlling the stem borers. - Makes points for (making reference to the data to support points) - Makes points against (making reference to the data to support points)	4

Discusses leaf area damaged for all stem borers

Sesamia – very little damage done for almost all types of genetically modified maize compared to control (mention specific maize types to back up)

Eldana – overall less damage done for all GT modified maize (B-I) Not much difference compared to control

Busseola – Caused most damage for all GT modified maize being very similar to control except for (use graph to back claim)

Overall judgement required for one mark

Note – maximum of two marks for those that described effects of most maize

Question 24 (c)

Criteria	Marks
- Demonstrates a thorough understanding of biodiversity - Demonstrates a thorough understanding of the relationship between the loss of biodiversity and the use of BT maize	3

Definition of biodiversity required showing an understanding of genetic and species

Species diversity

Species diversity refers to the variety of different types of species found in a particular area. It is the biodiversity at the most basic level. It includes all the species ranging from plants to different microorganism. No two individuals of the same species are exactly similar. For example, humans show a lot of diversity among themselves.

Genetic diversity

It refers to the variations among the genetic resources of the organisms. Every individual of a particular species differs from each other in their genetic constitution. That is why every human looks different from each other. Similarly, there are different varieties in the same species of rice, wheat, maize, barley, etc.

Loss of biodiversity – discussion about monocultures

- Impact of stem borers becoming extinct, affects food chain

Question 25(a)

Marking Criteria	Marks
- Trend in incidence described with numbers referenced - Trend in mortality described with numbers referenced. - Feasible suggestion given for rise in incidence. - Feasible suggestion given for subsequent decline - Feasible suggestion given for decline in mortality.	5
1-4 of the above	1-4

Incidence increases between 1975 and 1988 from about 95 to 120 cases per 100,000. Then it increases dramatically, reaching about 240 in 1992. It then declines sharply to about 165 by 1995. It then oscillates between 180 and 150 over the next 10 years.

The slow increase between 1975 and 1988 could be due to greater awareness amongst men, and hence greater testing and diagnosis. Alternatively it could reflect an aging population or an increase in an environmental factor which causes cancer. The sudden increase between 1988 and 1992 probably reflects the new adoption of PSA testing, leading to a much greater diagnosis rate. The decline and subsequent levelling out probably reflect the fact that a backlog of cases were picked up when the new test arrived, and that by 1995 this backlog had been cleared.

Mortality shows a very gradual increase between 1975 and about 1992 from about 30 to 45 deaths per 100,000.

Then it gradually drops, reaching about 25 by 2005. The initial increase could reflect an increase in cases before 1975 (there is a lag between incidence and death). It could also reflect an aging population or a decline in other causes of death. The decrease from 1992 onwards most likely reflects earlier diagnosis thanks to the PSA test, and hence earlier and more effective treatment.

Question 25(b)

Marking Criteria	Marks
- Role of DNA repair genes or genes controlling cell division described. - Explanation of how DNA damage can give rise to cancer.	3
One of the above and the other done less well.	2
One of the above.	1

DNA can become damaged due to the action of various mutagens. DNA repair genes produce proteins which are able to arrest gene expression and repair the DNA. Each repair protein is capable of effecting a particular repair – for example one can remove uracil from DNA. Damaged DNA will lead to the gene not functioning correctly – this can lead to a gene becoming an oncogene, one which promotes uncontrolled cell division and tumour development.

OR

Mutations of genes which regulate mitosis can cause uncontrolled cell division which can cause tumours. Eg: the p53 gene's role is to stop cells dividing if they contain harmful mutation. A mutation in the p53 gene will allow this uncontrolled cell division, leading to tumour formation.

Question 25 (c)

Marking Criteria	Marks
- Proposed study can be case control, or cohort study, but should contain: - Large numbers of people - An experimental and a control group - Consideration of other variables needing to be controlled - Data to be collected - Analysis of data	5
1-4 of the above	1-4

A case control study could be performed.

A large number of prostate cancer sufferers (circa 5000) should be randomly selected.

A similar sized group of men without prostate cancer should be selected.

This control group should have a similar age profile and demographic breakdown to the cancer group, as these are factors which are linked to cancer.

Both groups should be surveyed for dietary factors such as processed meat consumption.

The two groups should then be compared statistically in terms of processed meat consumption. A test for significance should be performed and whether or not there is a significant difference determined.

Question 26

Criteria	Marks
Provides a detailed knowledge and understanding of Pasteur and Koch's biological methodology and concepts and is able to adequately link these to the nature and transmission of disease	4

Pasteur showed that microbes caused disease and that microorganisms did not occur due to spontaneous generation, but came from pre-existing microorganisms.

He demonstrated this by boiling broth in swan-necked flasks and then breaking the top off on of the flasks, exposing the broth to air. The flask that was exposed to air then spoiled and the other remained uncontaminated, thereby showing that germs/pathogens are in the air and must be in contact with the host in order to cause disease. He developed pasteurisation, the heating of fluids such as milk to destroy pathogens, which was soon adopted as important way of preventing transmission of pathogens through food/drink. This led to a better understanding of the need for hygiene, sanitation and water treatment for the prevention of transmission.

Pasteur demonstrated the link between microbes, decay and disease and showed that microbes were not the product of disease and decay, but rather, the cause.

Koch was successful in identifying the cause of anthrax was a particular microbe. This led him to develop 4 postulates that must be satisfied to prove that a particular microorganism caused a particular disease. First the pathogen must be present in every host with the disease. Second, the microorganism must be isolated from the host and grown in a pure culture. Third, when a new host is inoculated with the microorganism, the new host must develop the same symptoms as the original host. Finally, this microorganism must be able to be isolated and compared to, and be the same as, the original microbe.

Robert Koch also developed techniques to artificially culture the bacteria, and discovered that the bacteria were able to produce spores that could survive harsh conditions, and that these spores could cause anthrax. This helped to explain why contaminated soil could remain toxic and infect animals, years after an initial outbreak had occurred. Koch recommended that diseased animals be burned or buried in very cold soils to prevent the formation of these spores.

Question 27

Criteria	Marks
Correctly identifies the regions labelled W & X Explains mRNA processing in eukaryotes AND a benefit of mRNA processing.	4
Correctly identifies the regions labelled W & X AND Explains mRNA processing in eukaryotes or a benefit of mRNA processing. OR Correctly identifies the regions labelled W & X AND Briefly outlines mRNA processing in eukaryotes AND a benefit of mRNA processing.	3
Correctly identifies the regions labelled W & X AND Briefly outlines mRNA processing in eukaryotes OR a benefit of mRNA processing.	2
Provides some relevant information	1

Regions labelled 'W' are exons and the regions labelled 'X' are introns. Eukaryote genes contain non-coding regions called introns and after transcription of the DNA the introns are removed by complexes called spliceosomes. The spliceosome also pastes the remains exons together to make the final, mature mRNA that is sent from the nucleus into the cytoplasm for translation.

mRNA processing can increase protein diversity through alternate splicing. Pre-mRNAs have a large number of exons that can be spliced together in different combinations to generate different mature mRNAs, each of which translates into a protein with a different structure. It allows the production of many different proteins using relatively few genes.

non-coding DNA was not accepted for label 'X'. Firstly the image shows RNA, and non-coding regions does not just encode for introns. Other non-coding DNA regions include promoters(binding sites), enhancers and silencers. It is not enough to say introns are cut out, you need to explain how it is 'spliced' out and explain only the introns are translated into functional proteins.

Question 28a

Criteria	Marks
Correctly identifies both the dependent and independent variable	1

Independent variable is the water source

Dependent variable is the % cover of bacterial colonies.

The number of bacteria is not the dependent variable. That is not how it was measured. The stimulus material did not mention counting the colonies.

Question 28 (b)

Criteria	Marks
Risk identified and a way to minimise the risk outlined.	1

All plates should be kept sealed after the experiment and autoclaved before disposal, so as to minimise the risk of exposure to a pathogen.

the risk needed to be appropriate to the experiment and realistic. Inhaling pathogens from the water source was NOT accepted

Question 28 (c)

Criteria	Marks
Identify the investigation as NOT valid AND Correct justification	2
Makes correct judgment but does not justify correctly	1

The experiment is not valid. While some control of variables was achieved through incubating at same temperature. There was no use of an experimental control. Uninoculated agar plates should have been used. This would have ensured the bacterial growth observed was indeed due to the sources of water and not something in the agar.

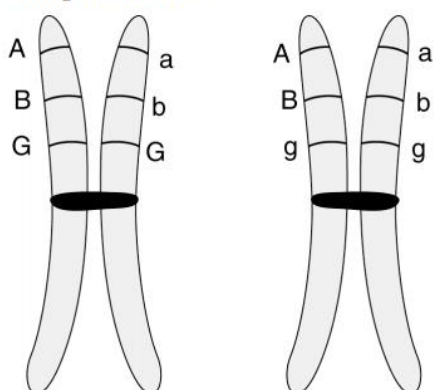
Also compromising validity was the use of an estimate to measure the % bacterial cover. A method that used a less subjective measure should have been used.

Only one plate was used for each water source, not able to assess reliability. It is not possible to know whether the results obtained were just due to chance, or whether they truly represent the amount of bacterial growth in different water sources.

Question 29 (a)

Criteria	Marks
• Provides correct sequence of alleles	1

Sample answer:



Question 29(b)

Criteria	Marks
• Relates independent assortment to variation of offspring	2
• Provides some relevant information	1

Sample answer:

Independent assortment is the random alignment of homologous chromosomes during meiosis. This increases the number of possible combinations of chromosomes. Therefore, it increases the genetic variation of the offspring.

Question 29(c)

Criteria	Marks
• Correctly describes at least two types of mutations that can result from errors that occur during meiosis	2
• Correctly describes one type of mutation that can result from errors that occur during meiosis	1

Sample answer:

Any two of:

- Non-disjunction of one pair of homologous chromosomes will result in trisomy or monosomy in the offspring, where there is one extra or one missing chromosome in the cells.
- Non-disjunction of all the chromosomes in the cell will result in polyploidy, where there are more than two sets of chromosomes in each cell.
- Incorrect crossing over during Metaphase I of meiosis can cause deletions, where some genes will be missing in the offspring.

Question 30

Criteria	Marks
• Describes a plant disease of agricultural significance • Describes the symptoms of the named disease • Describes the processes that have been used to prevent or control the disease	3
• Describes two of the three above	2
• Provides some relevant information	1

Sample answer:

Panama disease of bananas is caused by a fungus, *Fusarium oxysporum*. A strain of *Fusarium* was detected in Cavendish bananas in northern Queensland in 2015. The fungus infects the plant through the roots and damages the conducting tissues of the banana plant, causing discoloration of the vascular tissue and starving the plant of water and nutrients. There is no cure for the disease. The fungus is spread through water and soil, and spores can survive in soil for many years, so to control the disease any infected area must be quarantined and cannot be used for growing bananas again. All banana plants in the infected area must be destroyed and efforts must be made to prevent runoff of soil or water.

Description of the disease should include the name of the pathogen. Many examples were not 'agriculturally significant'

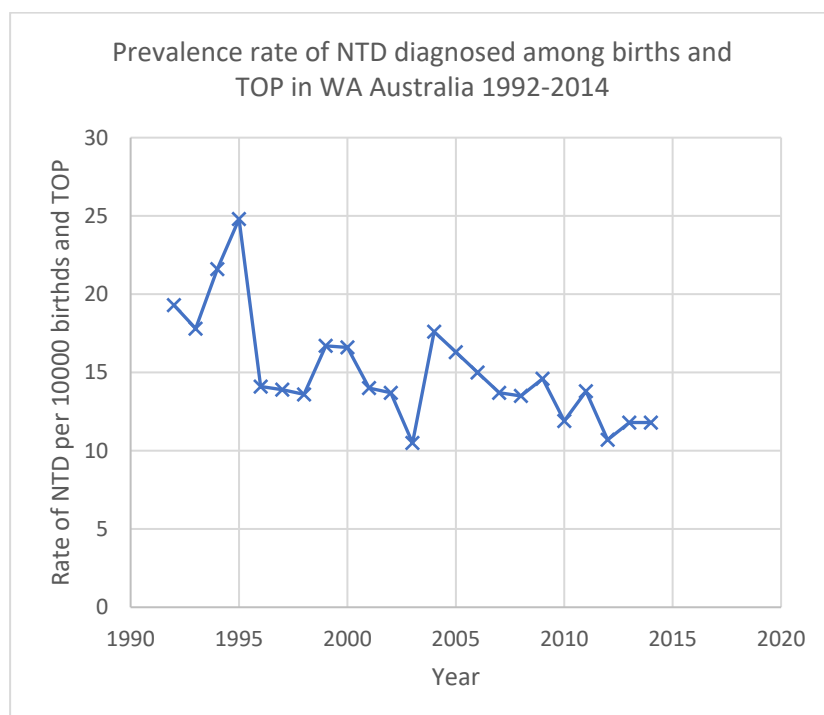
Question 31

Criteria	Marks
Identify stomata need to be open for gaseous exchange to provide carbon dioxide for photosynthesis, but will also result in water loss. Identify 2 adaptations of xerophytes and describe how it minimises water loss and still allows for gaseous exchange	4
Identify 2 adaptations of xerophytes and describe how it minimises water loss and still allows for gaseous exchange	3
Identifies an adaptations of xerophytes and describe how it minimises water loss and still allows for gaseous exchange	2
Identify 2 adaptations of xerophytes in relation to minimising water loss	1

you needed to identify the issue of balancing water loss and gaseous exchange. Many students explained how the adaptation minimises water loss but did not explain how it still allowed for gaseous exchange.

Question 32(a)

Criteria	Marks
• Correctly x & y axis with label • Plot points correctly • Line drawn dot to dot • Correct scale	3
• 1 of above missing/incorrect	2
• 2 of above missing/incorrect	1



Question 32 (b)

Criteria	Marks
• Identifies relationship between stated variables	2
• Identifies a trend	1

Prevalence of NTD decreases over time

Question 32(c)

Criteria	Marks
• Outlines differences between Aboriginal and non-Aboriginal NTD prevalence with reference to data • Links changes in prevalence to the two prevention strategies • Provides a valid reason for the difference in effectiveness of the prevention strategies on Aboriginal and non-Aboriginal groups	4
• Outlines differences between Aboriginal and non-Aboriginal NTD prevalence with reference to data • Links changes in prevalence to the prevention strategies • Provides a valid reason for the difference in effectiveness of the prevention strategy on Aboriginal and non-Aboriginal groups	3
• Outlines differences between Aboriginal and non-Aboriginal NTD • Provides a valid reason for the differences • OR • Links changes in prevalence to the two prevention strategies	2
• Outlines differences between Aboriginal and non-Aboriginal NTD	1

Following firm evidence of the protective effect of periconceptional folate, health promotion activities encouraged increased folate intake through diet and supplements.

~30% reduction in NTD was observed in non-Aboriginal but not Aboriginal infants, widening the disparity between Aboriginal and non-Aboriginal rates.

Health promotion activities, and voluntary fortification were not effective for Aboriginal populations. There were several potential reasons for this – the promotional messages to take folic acid supplements periconceptionally may not have been culturally appropriate, the cost may have been a barrier, and there may have been a high level of unplanned pregnancy. Also, the few voluntarily fortified foods available may not have been consumed by Aboriginal women of childbearing age.

The NTD prevalence in 2006–2009 (before mandatory fortification) for Aboriginal infants was 2.5 per 1000 (and 1.25 per 1000 for non-Aboriginal infants). Postfortification (2010–2014), the NTD prevalence was 0.75 per 1000 for Aboriginal and 1.00 per 1000 for non-Aboriginal infants; resulting in a disappearance of the disparity.

It is reasonable to suggest that folic acid fortification of bread flour was responsible for the increases in folate status in Aboriginal people and for the reduction in NTD prevalence in both the Aboriginal and non-Aboriginal populations

Question 33

Criteria	Marks
One similarity and one difference described Enclosed/segmented table	3
One similarity and one difference described Table not enclosed and not segmented OR One similarity described Enclosed/segmented table	2

One similarity described OR Table drawn correctly	1
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Antivirals	Antibiotics
antivirals are usually very specific, used to treat a narrower range of viruses	Antibiotics can be narrow or wide spectrum. Acting very specifically or on a wide range of bacteria.
Need to be taken in early stages of infection to be effective. Effectiveness usually diminishes markedly after 48 hours.	Can be used effectively later in the illness.
Bacteria and viruses mutate over time and develop resistance to antibiotic and antiviral drugs respectively.	

Question 34

Criteria	Marks
• Demonstrates coherence and logical progression and includes correct use of biological terms • Demonstrates thorough knowledge of protein synthesis • Demonstrates thorough knowledge of the technology used to create a recombinant plasmid. • Relates the protein that is synthesised (antigen) induces an immune response • Demonstrates thorough knowledge of the specific immune response • Demonstrates thorough knowledge of the mechanism of a vaccine in rendering immunity to the individual • Demonstrates thorough knowledge of the secondary immune response	8
Detailed description of • the technology used to create a recombinant plasmid. • the production of the antigen through protein synthesis • how the protein that is synthesised (antigen) induces an immune response • the specific immune response • the mechanism of a vaccine in rendering immunity to the individual • the secondary immune response	6-7
Description of most of • the technology used to create a recombinant plasmid. • the production of the antigen through protein synthesis • how the protein that is synthesised (antigen) induces an immune response • the specific immune response • the mechanism of a vaccine in inducing immunity to the individual • the secondary immune response	4-5
Answer contains some description of • the technology used to create a recombinant plasmid. • the production of the antigen through protein synthesis • how the protein that is synthesised (antigen) induces an immune response • the specific immune response • the mechanism of a vaccine in inducing immunity to the individual • the secondary immune response	2-3

Provides some relevant information	1
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Criteria	Marks
Correct prediction Justification	2

27kb or longer than the mature mRNA in a eukaryotic cell. mRNA processing typically does not occur in prokaryotes