Diocesan Boys' School
G12 Final Examination
Jan 2023
BIOLOGY
Answer Key

PAPER 1

SECTION 1A

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

SECTION 1B

1. A, C, D [1]
   C [1]
   C, D [1]
   D [1]

2. (a) Palisade mesophyll [1]
   The cells are closely packed. [1]
   (b) Cells in sample P are ***cylindrical*** and Cells in sample Q are ***round.*** [1]
   The cellulase broke down the ***cell walls*** in sample Q. [1]
   Thus the cells ***lose support*** / shape cannot be maintained. [1]
   (c) The ***water potential*** of distilled water is ***higher*** than the cells, leading to (a ***net*** movement of) water molecules ***into*** the cells ***by osmosis***.[1]
   With cell walls, cells in sample P ***swell without bursting /remain intact***. [1]
   Without cell walls, cells in sample Q ***swell and burst / disappear***.[1]

3. (a) Deforestation ***reduces*** the ***porosity*** of the soil. [1]
The level in ***oxygen*** is ***lowered***. [1]

(b) With lower oxygen level, the rate of ***aerobic respiration*** of root hair cells is ***lowered***.[1]
Less energy is available for ***active transport*** of minerals. [1]

(c) (i) The amount of ammonium compounds in the soil of grassland is ***lower*** than that in the primary forest. [1] **decrease / increase [0]**
As ***less oxygen*** is available for the ***decomposition*** of organic materials by microorganisms / decomposition is an ***aerobic*** process. [1]

(ii) The amount of inorganic nitrogen in the soil of grassland is ***lower*** than that in the primary forest. [1] **decrease / increase [0]**
As the rate of ***nitrification*** is ***reduced*** as it is an ***aerobic*** process / this will favour denitrification as it is an anaerobic process. [1]

(d) Crop-growing involves a ***shorter food chain*** than cattle raising. [1]
Less energy is ***lost*** along the food chain [1]
by [respiration as heat / excretory products] and [uneaten materials / undigested materials / egestion] (name any one reason from each group) [1]
Thus ***more energy*** in the form of ***organic food*** / matter is available for human consumption. [1]

4. (a) ***Antigens*** of COVID-19 virus / weakened virus [1]

(b) Cancer cells can divide unlimitedly/excessively. [1]
The fused cells can produce the required antibodies continuously /a large amount of the required antibodies.[1]

(c) bone marrow / spleen / lymph node [1]

(d) (i) (Artificial) ***Passive*** immunity [1]

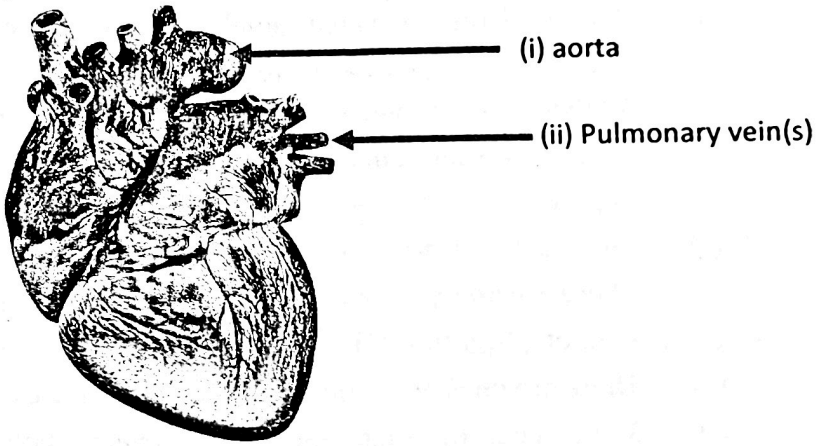
(ii) The antibodies clump the virus together.
The antibodies facilitate the phagocytes to engulf the viral particles.
The antibodies neutralize the toxins produced by the virus.
(Any two) [2]

(iii) After the injection, he would have a high level of antibodies against the COVID-19 virus in his body / above the minimum level of effective immunity against COVID-19. [1]
Upon infection of COVID-19, the antibodies act against the virus quickly. [1]
No symptoms would appear. [1]
His claim is valid. [1]
OR
His claim is invalid. [1]

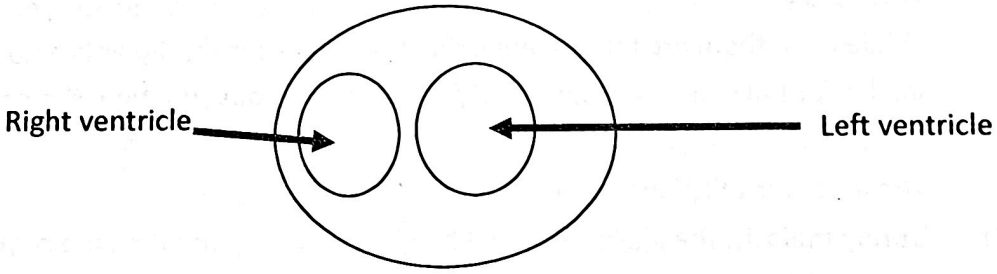
The levels of antibodies would drop quickly after injection. [1]
And he has no memory cells produced for COVID-19 viruses. [1]
No secondary responses will be triggered / Antibodies would be produced very slowly upon exposure to the virus. [1]

5. (a) (i) Correct label of aorta (with question number / labelled "highest blood pressure") [1]

(ii) Correct label of pulmonary veins (with question number / labelled "highest oxygen concentration")[1]



(b)



Correct relative thickness of wall [1]
Correct labeling (left ventricle [1] Right ventricle [1])

(c) Rate of blood flow to the cardiac muscles decreases. [1]
Less oxygen and nutrients are supplied to the cardiac muscle cells. [1]
The heart muscle cells die / leading to heart attack / cardiac arrest. [1]

6. (a) The *temperature at* 1400 is *higher* than 2000. [1]
The rate of *evaporation* of water is *higher* at 1400 than 2000. [1]
The rate of *transpiration* is *higher* at 1400 than 2000. [1]
OR
The *light intensity* is *higher* at 1400 than 2000. [1]
The *stomata* open *wider* at 1400 than 2000. [1]
The rate of *transpiration* is *higher* at 1400 than 2000. [1]

(b) Transpiration of water produces ***transpiration pull*** in the xylem vessels [1]
which *induces* water absorption from the soil at the roots. [1]

(c) Area X is larger than area Y implying there is an (overall) ***net water loss*** from the plant / water loss is higher than water absorption. [1]
With inadequate supply of water, the plant ***loses support by turgidity*** of thin-walled cells / cells cannot maintain their turgidity and cannot support the plant upright[1]

7. (a) There are *intermediate* phenotypes / height observed in both short and tall plants [1]
There are *no medium* height plants / height of plants are separated into two distinct phenotypic groups [1]

(b) There are *environmental factors* affecting the expression of alleles [1]

(c) Since all parents are pure-bred, the F_1 generation must be heterozygous in the gene controlling height [1]
While all of them are tall, meaning that the alleles for short plants are masked and the alleles for tall plants are expressed / In a heterozygous situation, the dominant allele will be expressed [1]
The allele for tall plants are dominant.

(d) During meiosis, the alleles for plant height of the F_1 generation are *segregated* (randomly) into the gametes. [1]
Since F_1 is heterozygous for plant height, two types of gametes would be produced. [1]
After *random fertilization*, F_2 generations with different allele combinations for plant heights are produced, [1]
leading to the production of F_2 plants with both phenotypes [1]

8. (a) Less neurotransmitter can bind with the receptor sites on the dendrons of the next neurone. [1]

The ***nerve impulse transmission*** across the synapses in the brain is ***hindered*** / less nerve impulse can be initiated. [1]

(b) (i) A ***gene*** mutation would lead to the production of a ***wrong base sequence*** on ***mRNA*** during ***transcription*** [1]

A ***polypeptide*** with ***wrong amino acid sequence*** would be produced during ***translation*** [1]

which affects the folding and coiling of the polypeptide / 3D conformation / ***shape*** of the active site of the enzyme [1]

(ii) The people in Town A are ***isolated*** by the mountain range [1]

Restricting / reducing the gene flow with people outside the Town A / leading to ***inbreeding*** of people within Town A [1]

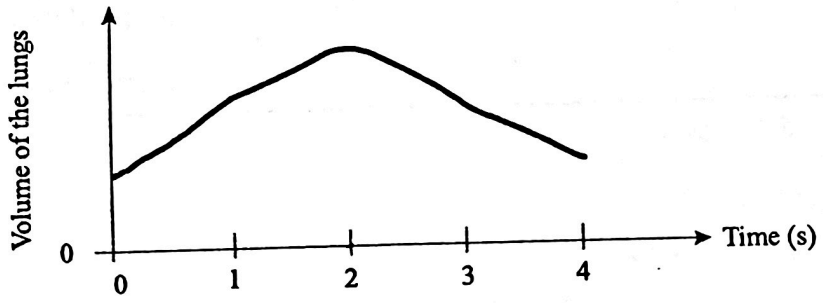
The alleles for this type of Alzheimer's disease are inherited in the subsequent generation / increased the ***homozygosity*** of this gene / Increased the proportion of people being homozygous for this mutation

(c) This mutation does not affect the survival of the individual before reproductive ages [1]

9. (a) 0-2 s [1]

The pressure of the lungs is lower than the atmosphere pressure [1]

(b) Correct curve [1 or 0]



(c) The air sacs of emphysema patients are damaged leading to smaller respiratory surfaces [1]

Oxygen diffuses into the blood at a lower rate [1]

10. Content (max. 8M) Effective communication (max. 3M)

	Infectious diseases e.g. COVID-19	**Non-infectious diseases** e.g. diabetes
1. Causes (max. 3M)	• caused by pathogens (1)* e.g. coronavirus (1)	• not caused by pathogens (1)* • caused by unhealthy lifestyles or heredity (1) e.g. lack of exercise and over-eating leading to obesity (1)
2.Preventionof diseases (max. 3M)	• prevented by breaking the transmission link of pathogens (1) e.g. any correct example of preventive method (1)	• cannot be prevented if caused by heredity (1) • prevented by healthy lifestyle if caused by unhealthy lifestyle (1) • e.g. any correct example of preventive method (1)
3. Treatment of diseases (max. 3M)	• can be treated by drugs/antibiotics/sulpha drugs (1) • e.g. antiviral drugs for COVID-19 etc. (1)	• Cannot be treated/can only be controlled (1) e.g. any correct example of control method (injection of insulin, restrict dietary carbohydrate intake etc.) (1)

*to be awarded as a pair

PAPER 2

SECTION A

1. (a) (i) The surge in LH (and FSH) concentration on the day of ovulation stimulated [1] the ruptured follicle to develop into corpus luteum/yellow body. [1]
The corpus luteum/yellow body subsequently secreted progesterone. [1]

(ii) Day 15 [1]
Ovulation was brought about by the surge in LH (and FSH) concentration. [1]

(iii) From day 1 to day 15:
rise to a peak and then return to low level [0.5]
oestrogen conc. before ovulation higher than oestrogen conc. after ovulation [0.5]
From day 15 to day 28:
rise to a peak and then return to low level [0.5]
oestrogen conc. lower than progesterone conc. [0.5]

(iv) The peak concentration of progesterone appeared ***earlier*** (day 14 instead of day 20) / The peak concentration of progesterone was ***higher***. [1]
The peak concentration of LH appeared ***earlier*** (day 10 instead of day 15) / The peak concentration of LH was ***higher***. [1]

(v) ***Earlier*** peak of progesterone concentration (on day 14) would lead to ***earlier*** maintenance of the thickened and vascularized uterine lining (on day 14) to match with ***earlier*** implantation (due to copulation on day 5).
OR
Higher peak of progesterone concentration would have a ***higher*** chance of maintaining the thickened and vascularized uterine lining for subsequent implantation. [1]

Earlier peak of LH concentration (on day 10) would lead to ***earlier*** ovulation (day 10) to match with ***earlier*** fertilization (due to copulation on day 5). [1]
OR
Higher peak of LH concentration would have a ***higher*** chance of stimulating ovulation for subsequent fertilization. [1]

(b) (i) Total volume of blood pumped by each ventricle per minute [1]

(ii) The rise in blood lactate concentration results in a drop in blood pH, which is detected by chemoreceptors in medulla oblongata. [1]
The cardiovascular centre in the medulla oblongata sends more nerve impulses to the pacemaker / sinoatrial node along the sympathetic nerve. [1]
the pacemaker / sinoatrial node generates more electrical impulses that spread through the cardiac muscles / heart muscles. [1]
This causes the cardiac muscles / heart muscles to contract more rapidly and more strongly, which increases the cardiac output. [1] (any 3)

(iii) Thermoreceptors in the hypothalamus detects the increase in body temperature. [1]
Heat loss centre in the hypothalamus is stimulated to send out nerve impulses to the skin. [1]
Arterioles dilates to increase blood flow to the skin surface [1]
and thus increases heat loss through radiation/convection/conduction. [1]
OR
Sweat glands secretes more sweat [1]
to increase heat loss through evaporation of sweat. [1] (any 3)

(iv) Osmoreceptors in the hypothalamus detects a lower water potential in the blood of sprinters. [1]
The hypothalamus in turn stimulates the pituitary gland and the pituitary gland to release more ADH into the blood.[1]
More ADH increases the permeability of the second coiled tubule and the collecting duct to water.[1]
As a result, a larger proportion of water is reabsorbed from the second coiled tubule and the collecting duct.[1]
A smaller volume of hypertonic urine is produced accordingly. (any 3)

SECTION B

2. (a) (i) Food poisoning [1]

Food poisoning is caused by ingesting food contaminated by toxins already present in food. [1]

This type of food-borne illness can occur as early as one hour after the meal, as evidenced by the first two reported cases. [1]

(ii) Advantage: quick and easy [1]

Limitation: both dead and living microorganisms are counted [1]

(iii) Number of microorganisms

$= 5 \times 10^6 \times 100 \div 100$ [1]

$= 5 \times 10^6$ [1]

(iv) The reported cases couldn't be food-borne infection / caused by living microorganisms. [1]

This is because the number of microorganisms measured by the optical method was not sufficient/too small (less than 10 000 000) to cause food-borne infection even if all of the microorganisms were living. [1]

we can conclude that the reported cases belonged to food poisoning.[1]

(b) (i) *Lactobacillus*/Lactic acid bacterium [1]

(ii) Low pH coagulates/curdles the milk [1]

Low pH provides an acidic medium/optimum pH for the enzyme (added 5 hours later) to function properly [1]

(iii) Protein [0.5]

Fat [0.5]

(iv) Remove animal fat which is saturated [1]

Replaced by vegetable oil which is unsaturated. [1]

(v) Yogurt is sour in taste but cheese is not[1]

because liquid whey containing lactic acid is retained in yogurt but not in cheese. [1]

Yogurt is semi-solid but cheese is solid [1]

because protein curd is shaped by pressing with weights in cheese but not in yogurt. [1]

SECTION C

3. (a) (i)

Double-stranded DNA [1]

Correct positions of the primers and STR region [1]

(ii) Bind to the unique sequences flanking the STR region / the target DNA [1]

To ensure only the segment of target DNA is amplified [1]

(iii) Ben is homozygous / with allele(s) of the same number of repeats for the gene coding the specific STR [1]

While his family members are heterozygous / with alleles of different number of repeats [1]

(iv) As Jack and Mary have 5, 3 and 3, 2 repeats in the STRs respectively, the possible numbers of repeats in the STRs of Katy are 2, 3 and 5. [1]

As one member of the homologous chromosomes of an individual comes from father and the other comes from mother [1]

for an individual to be a child of Katy, the number of repeats in the STR on one of the homologous chromosomes must be either 2, 3 or 5. [1]

The numbers of repeats in the STRs of child X are 1 and 4. Therefore, it is not possible for child X to be the biological sibling of Ben. [1]

(b) (i) The working CFTR gene can be delivered to internal organs more efficiently / it is difficult to isolate cells of internal organs for ex vivo gene therapy / less time-consuming [1]

(ii) The working gene can be delivered to all types of cells [1]

The effect of the treatment could be more widespread. [1]

(iii) The insertion of the gene may disrupt the base sequence of an existing gene / leading to the production of non-functional polypeptide [1]/

The insertion of the gene may affect the expression of an existing gene [1] / This may lead to diseases such as cancer. [1] (max 2)

(iv) (1) Since adenovirus will not integrate the gene into the genome of target cells, the gene will be lost gradually when the cells divide or die / the gene will be degraded [1]

Therefore, repeated treatments using adenovirus are required to sustain the effect of gene therapy / maintain the production of functional protein [1]

(2) The initial injections of adenovirus may trigger the (B) lymphocytes to differentiate into memory (B) cells (and plasma cells) specific to the antigens of the adenovirus [1]

When adenovirus with the same antigens is injected into the body again [1]
The memory B cells will produce a large amount of antibodies against adenovirus in a short period of time / trigger the secondary immune response to act against the adenovirus [1]
This lowers the effectiveness of the gene therapy