

Biology

Paper 1A

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

Paper 1B

1. (a) (secondary succession)
- (b) Development of woodland promotes increase of abundance and diversity of plant species, which in turn boost the availability of new food sources such as insects, fruits and seeds. (1)

The increase of food sources will attract a wider range of bird species that feeds on different specialized diets (1)

Varied plantations in woodland offered a more complex and diversified habitat for different birds, which both provide protection and ground for reproduction, and further boost species diversity. (1)

Increased types of food sources and *more complex / diversified habitat* offer multiple new ecological niches for a larger number of bird species to settle in the new ecosystem. (1)

- (c) (i) Temperature (1) & Carbon dioxide concentration (1)
- (ii) Shade plant has a lower compensation point than sun plant at low light intensity (1)

2. (a) A higher glucose concentration in growth medium indicates a higher cellulase activity. (1)
The following answers are not accepted: positive relationship, (directly) proportional
- (b) Any reasonable answer such as:
The temperature for the experiment. (1)
The initial amount of bacteria in the growth medium (1)
The volume of growth medium added to digest the paper. (1)
Types/thickness/sizes of paper being digested. (1)
- (c) A standard curve can be prepared by weighing the brick-red precipitate formed by glucose solution of different concentrations. (1)
By weighing the brick-red precipitate formed in the growth medium. (1)
We can find the corresponding glucose concentration by comparing the result to the standard curve. (1)
- (d) (i) When the pH is higher than the optimal pH, the cellulase activity drops (when the pH increases). (1)
When pH increases, *more and more cellulase are being denatured or as the shape of the cellulase active site is being altered. (1)
The active sites becomes *less and less able to fit the substrate/ to form enzyme-substrate complex. / *more and more cellulose molecules can't bind with cellulase (1)

*this concept is marked once, without this concept, 1 mark deducted.
- (ii) Cellulose degradation can be performed at neutral pH (1) which causes less harm to the environment. (1)
- (e) The pH of the bacterial culture has negligible effect on the growth of bacteria/health of bacteria/production rate of catalase/glucose absorption rate. (1)

3. (a) Individual 4 is normal. She must have at least one normal allele that is inherited from either of her parents, individual 1 or 2. (1)
Both individuals 1 and 2 have Li-Fraumeni syndrome. They must have at least one allele for Li-Fraumeni syndrome. (1)
Hence, at least one of individual 1 or 2 is heterozygous. (1)
In a heterozygous condition, only the dominant allele can express its effect. (1)
As both individuals 1 and 2 have Li-Fraumeni syndrome, the allele for Li-Fraumeni syndrome must be dominant. (1)
- (b) The allele for Li-Fraumeni syndrome is not Y-linked because females are affected. (1)
If the dominant allele for Li-Fraumeni syndrome is X-linked, individual 1 who has the syndrome must have the allele on his X-chromosome. (1)
The X chromosome must be passed on to his daughter, individual 4. (1)
However, individual 4 is normal. Thus, the allele is not X-linked. (1)
- (c) As the protein becomes non-functional, the ability to repair DNA damages in cells is reduced. (1)
The cells with damaged DNA continue to divide uncontrollably, forming tumours. (1)
As mutations accumulate, a tumour cell becomes cancerous and spreads to other parts of the body. (1)

4. (a) His ciliary muscle contracts (1)
Causes the suspensory ligament to slacken (decrease in tension) (1)
*do not accept relax
The lenses then rebound to become thicker / more convex as it is elastic, enabling him to see the incoming ball. (1)
- (b) W & Y (1)
- (c) Ligament (1)
- (d) Ice packs can lower the temperature of the affected region once applied.
This decrease in temperature will stimulate vasoconstriction / constriction of the arteriole nearby
And decrease blood flow there, reducing the speed of tissue fluid formation (1)
As the tissue fluid is now being produced in a slower rate and being drained / removed constantly (1), the fluid accumulation improved and the swelling decreased.(1)
5. (a) To move the liquid / reset the water level in the capillary tube (1)
- (b) (i) Oxygen is consumed by the germinating seeds as they carried out aerobic respiration. (1)
and the released carbon dioxide was absorbed by potassium hydroxide. (1)
Thus, the air pressure inside the container is lower than that of the atmosphere (1),
and the water was drawn up.
- (ii) At higher temperature, the respiration rate is higher. (1)
More oxygen in the container is consumed. (1)
As a result, the water level increased more in 30°C than in 24°C. (1)
- (c) The roll of filter paper will soak up the potassium hydroxide solution and provide a larger surface area to absorb CO₂ more quickly. (1)

6. (a) (i) The number of cases of Men-B decreased significantly starting from 1999 and remained at low levels.(1)
- (ii) The vaccine contains antigens of Men-B bacteria (1)
 which stimulate B cells to multiply and differentiate into memory cells and plasma cells.(1)
 Upon subsequent exposure to Men-B bacteria(1)
 the memory cells are activated and capable of producing large amounts of antibodies in a short time.
 (1)
- (b) (i) No.(1) The number of cases of Men-C remained high from 1999 onwards. (1)
- (ii) Men-C bacteria have different antigens from Men-B bacteria. (1)
 The memory cells developed against Men-B bacteria cannot recognize the antigens of Men-C bacteria.
 (1)
7. (a) Due to the formation of the Isthmus of Panama, the ancestral population was separated into two groups and the two groups became isolated from each other / could not meet to interbreed and gene flow stopped(1)
 Each isolated group was subjected to a different set of environmental conditions. (1)
 The two groups evolved differently due to natural selection. / Different characters favourable to those particular environmental conditions were selected by natural selection. (1)
 Over time, their genetic compositions became so different that they could no longer interbreed to produce fertile offspring even if they met again. They became two different species. (1)
- (b) (1a) →(2)
 (1b) →(3)
 (2a) Without two vertical black stripes behind its head (or other reasonable answers)
 (2b) With two vertical black stripes behind its head (or other reasonable answers)
 (3a) Fish R
 (3b) Fish S

8. (a) It stimulates protein synthesis for muscle development. (1)
- (b) It stimulates the conversion of glucose to glycogen. (1)
More glycogen in the body increases the mass. (1)
- (c) Extra insulin would lead to very low blood glucose level (1)
that is not sufficient for respiration.(1)
- (d) (i) The hormone was a protein which was digested by the digestive enzymes/ proteases present in the extract. (1)
- (ii) From the work of other scientists, Banting and Best knew that diabetes mellitus was caused by the lack of a hormone secreted by the pancreas. They therefore tried to cure diabetes mellitus by supplying the missing hormone. (1)

OR

From an article written by Baron, Banting learnt that blocking the pancreatic duct led to degeneration of the pancreatic cells which secrete digestive enzymes, but not the islets of Langerhans. This gave Banting the idea of obtaining an extract of the islets of Langerhans free from the destroying influence of digestive enzymes. (1)

9. **HSP Molecular Significance: (3)**

- The inserted DNA sequence serves as a template for **transcription** in the nucleus to produce mRNA, which encodes for the Heat Shock Protein. (1)
- The sequence of mRNA codons determines the **primary structure** (amino acid sequence) of the HSP, which then folds into a specific **3D conformation**. (1)
- HSPs are specialized proteins that bind to other enzymes when the temperature rises, preventing them from **denaturing**. (1)

Coral Bleaching prevention mechanism : (3)

- HSPs specifically protect the proteins in the chloroplasts of **Zooxanthellae** (symbiotic algae), allowing them to continue performing photosynthesis. (1)
- Because the algae are protected, the coral does not "expel" them. This prevents **coral bleaching**, ensuring the coral continues to receive glucose from the algae. (1)
- The ability to maintain this symbiotic relationship during a heatwave increases the **survival rate** of the modified coral compared to native, non-modified species. (1)

Evolutionary Impact of HSP gene introduction : (2)

- The trait for heat resistance is introduced by humans rather than through random mutation and natural selection over generations. (1)
- If "Super-Corals" dominate the reef, the **genetic diversity** of the coral population may decrease, making the entire ecosystem vulnerable to other unknown future threats (1)

Ecological impact of Super Coral Project : (choose 2 out of 3)

- Corals are **primary producers** (via their algae); by preventing their death, the energy flow to primary consumers (fish) and higher trophic levels is preserved. (1)
- Preservation of the reef ensures that the **structural complexity** (habitat) and the **primary productivity** (food source) are maintained. This preserves the **ecological niches** of various marine species, ensuring the **stability** and integrity of the entire ecosystem.". (1)
- While this protects the **niche** of many reef species, it may disrupt the natural **interspecific competition**, potentially allowing the Super-Coral to outcompete their natural counterparts and might slightly reduce the species richness in total. (1)

3 marks for effective communications

Paper 2

1. (a) (i) The cortex of the kidney (1)
- (ii) C and D are cut at different angles / planes. (1)
- (iii) The concentration of glucose in A (glomerulus) is the same as that in B (Bowman's capsule). (1)
During ultrafiltration, glucose molecules in the blood in A pass through the walls of A and B and enter the capsular space. (1)
The concentration of proteins in A is higher than that in B. (1)
Protein molecules in A are too large to pass through the walls of A and B. They are retained in A. (1)
- (b) (i) A large amount of heat is generated by the respiration of muscle cells during heavy exercise (1)
Increased sweat production promotes heat loss from the body by evaporation of sweat (1)
To prevent the body from overheating / heat stroke (1)
- (ii) A large amount of water is lost from the body in the form of sweat during heavy exercise (1)
The hypothalamus detects a decrease in water potential of the blood (1)
The pituitary gland releases more ADH into the blood circulation (1)
As a result, the wall of the collecting ducts of the kidney tubules become more permeable to water (1)
Thus, a greater proportion of water is reabsorbed and a smaller volume of urine is produced(1)
- (iii) During heavy exercise, the rate and depth of breathing increase,
A larger volume of air was exhaled from the lungs per unit time (1)
And hence, water loss in the form of water vapour increases (1)
- (iv) From 0 to 2 minutes, the core body temperature dropped (1)
because body heat was lost to the cold water by conduction. (1)
From 2 to 10 minutes, the core body temperature dropped at a lower rate. (1)
The cold water caused vasoconstriction in the skin. Less blood flowed through the capillaries near the skin surface, resulting in reduced heat loss from the body. (1)

2. (a) (i) Without tree roots to hold the soil particles in place, (1)
soil erosion / desertification is more likely to occur. (1)
- (ii) Comparing with the species composition at the beginning of the programme, the number of individuals of species R increased greatly while the number of individuals of species P, Q and S decreased. (1)
The relative abundance of species R became much higher than that of other species. (1)
This shows that the species diversity of the plant community in region X decreased.
Thus, the restoration programme in region X is unsuccessful in terms of improving the species diversity.(1)
- (iii) The population size of species R decreased from 1992 to 2002. (1)
Plus any 1 of the following:
– Specific nutrients in the soil were depleted as species R became dominant species. (1)
– Species R may be killed by diseases or pests. (1)
- (iv) The native animal community would decline / native animal species which are more adapted to the non-native plant community would become the dominant species (1)
as the population sizes of native plant species P and Q decreased from 1992 to 2002, (1)
leading to a decrease in the availability of food / habitats for the native animal species. (1)
- (b) (i) The atmospheric carbon dioxide concentration increases from 1960 to 2020 (1)
as fossil fuel consumption has increased / more forests have been cut. (1)
The atmospheric carbon dioxide concentration shows fluctuation annually. (1)
It is because the day length is longer / air temperature is higher in summer than in winter, so photosynthetic rate is higher in summer. Plants consume more CO₂ in the atmosphere. (1)
- (ii) **Arguments for the claim:**
Algae consume a large amount of carbon dioxide dissolved in the water for photosynthesis.(1)
More carbon dioxide can diffuse from the atmosphere to the water. (1)
Arguments against the claim:
Algae grows densely and covers the water surface. This prevents sunlight from penetrating the water. Aquatic plants cannot obtain sufficient light for photosynthesis and may die (1)
leading to a decrease in the overall photosynthetic rate and thus a reduction in the removal of carbon dioxide from the atmosphere. (1)
- (iii) With lower HCFCs emissions, the atmosphere traps less heat reflected from the Earth's surface. (1)
This helps slow down the increase in the atmospheric temperature. (1)

3. (a) (i) Methanogens cannot digest the organic wastes. (1)

Other anaerobes are used to break down organic wastes into carbon dioxide, hydrogen and other simple substances. (1)

These simple substances can be utilized by the methanogens. (1)

(ii) $13 \div 0.0004 \times 200$ (1)

= 6 500 000 cells / mm³ (1)

(iii) (1) turbidity / dry mass (1)

(2) Turbidity

Advantage: quick / less subjective / continuous / no disturbance of culture (1)

Disadvantage: problems with clumping / need to calibrate (1)

OR

Dry mass

Advantage: less subjective (1)

Disadvantage: time-consuming / measurement is not continuous (1)

(3) Turbidity

The result of turbidity is lower than that of cell count. (1)

The cells may clump or sink in the bottom. (1)

OR

Dry mass

The result of dry mass is the same as that of cell count. (1)

Dead cells and viable cells are counted in both methods. (1)

3. (b) (i) Food-borne infection (1)

(ii) 7.5 seconds (1)

(iii) Enzyme B. (1)

From the graph, the denaturation of enzyme B requires a longer duration than the killing of *M. bovis* under the same temperature (or enzyme B has a higher tolerance to heat than *M. bovis*). (1)

If no activity of enzyme B is detected in a pasteurized milk sample, there should be no living *M. bovis* bacteria in the milk.(1)

(iv) No.(1)

(Followed by any 2 of the following explanations):

- Raw milk is not healthier as it may contain *M. bovis* or other pathogens that cause serious disease/death. (1)
- Pasteurized milk is as nutritious as raw milk as the temperature is not high enough to destroy most nutrients. (1)
- Raw milk is not better for lactose intolerance as it still contains lactose / lacks lactase. (1)

(v) Ultra high temperature treatment (UHT). (1)

Milk is heated to 135 °C for 3-5 seconds to kill all spoilage microorganisms.(1)

4. (a) (i) Shortened mRNA contains less codons (1)
Shorter polypeptide fold to a different shape and lose its function (1)
- (b) Recessive. (1)
For SMA to develop, the individual must have two chromosome 5 / SMN1- (1)
OR
deletion of SMN1 on both chromosomes (1)
so there is no (functional) SMN protein being produced and causes SMA (1)
- (c) (i) Denature DNA molecules at high temperature to form single-stranded DNA (1)
At a lower temperature, allow annealing of suitable primers that flank SMN genes (1)
Increase temperature again, with complementary free nucleotides, DNA molecule is extended by Taq polymerase (1)
- (ii) PCR product of SMN1 and SMN2 are of the same size and will be in the same band if run on gel together / gel electrophoresis cannot separate SMN1 from SMN 2 (1)
As only SMN2 contains the restriction site, adding the restriction enzyme can help distinguish SMN1 and SMN2 during gel electrophoresis. (1)
- (iii) (1) A (1)
(2) Thinner band indicates there is less PCR products (1)
Because individual C is heterozygous for / just have one copy of SMN1 gene. (1)
- (d) (i) A viral vector is used to carry the working SMN / SMN1 / normal gene (1)
The viral vector delivers and inserts the normal gene into the patient's genome / cell (1)
This inserted gene is expressed to produce functional SMN protein which should overcome the defect (1)
- (ii) Antibodies / immune reactions develop against the viruses if exposed before. (1)
Will destroy /attack the viral vector and corrective gene cannot be delivered to target cells (1)
- (iii) Treatment 1 is long-term treatment because once the working SMN gene is inserted into motor neurones the normal SMN proteins can be produced by the cells (1)
Treatment 2 is not as it does not alter the SMN2 gene, the individual could not produce functional SMN protein as long as the drug is administered. (1)