2024 Sec 4 Prelim Biology Marking Scheme

Paper 1

1	B	2	A	3	C	4	A	5	C	6	C	7.	B	8.	B	9	C	10	C
11	A	12	D	13	C	14	C	15	A	16	D	17.	C	18.	D	19	C	20	B
21	C	22	D	23	A	24	B	25.	C	26.	C	27.	B	28.	D	29	B	30	B
31	A	32	B	33	C	34	B	35.	B	36.	C	37.	D	38.	D	39.	D	40.	B

Paper 2 Section A

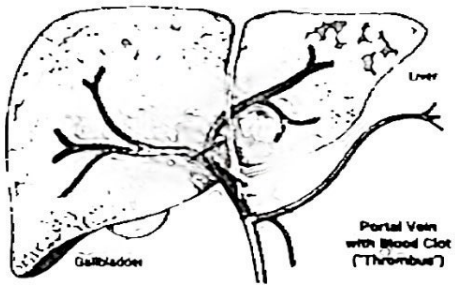
Qn	Suggested Response	Remarks
1a	D A deoxyribonucleic acid (mark is penalised for wrong spelling)	Almost half of the cohort answered wrongly, with genes and ribosomes as the most common wrong answers
b	**cheek cell** / **sperm cell** Circular/ oval / elongated No flagellum/ tail / Has flagellum/ tail Large volume of cytoplasm / Lesser volume of cytoplasm Nucleus in centre of cell / Nucleus in head of sperm cell Less mitochondria / Numerous mitochondria Regularly shaped nucleus / Irregularly shaped nucleus Absence of acrosome / Presence of acrosome Each full comparison .	R streamlined body, long & thin shape long & narrow protrusion, pear-shaped nucleus to describe the sperm cell Candidates are to use their knowledge of the cheek cell and sperm cell to answer this question. Many inappropriate adjectives to describe the sperm cell are rejected The dots in the cheek cell represent the cytoplasm, but this does not mean it is granular while there is no cytoplasm in the sperm cell! The comparison was not always relevant such as length of sperm cell vs shape of cheek cell. Any dimension such as width and diameter used to compare was irrelevant. There are better answers besides the dimensions!
c	sperm cell : Y + ovum X . explanation Sex chromosomes in male is XY . ovum contains only X chromosome and sperm cell contains either X or Y chromosome .	Many did not understand the requirements of the question and wrote XY for sperm cell and XX for ovum
d	One set of unpaired chromosomes/ half the number of chromosome as compared to body/ somatic cells . _____rd number/ complete/ full set of chromosomes ; restored during fertilization/ when gametes fuse / a diploid zygote is formed when gametes fuse .	R n number, 23, original number, same number of chromosomes Many referred to the parent cell without providing the context of meiosis. Many responses linked to the ideas of genetic variations and natural selection which are irrelevant!

2a	blue .	Generally well done
bi	allele where it is expressed in homozygous dominant or heterozygous / mask the effect of a recessive allele	R overpower, override Majority did not write the correct definitions. Some were confused with the terms 'homozygous' and 'homologous' between 'allele', 'gene' and 'genotype'
ii	allele where it can only be expressed in a homozygous recessive genotype/ can be masked by dominant allele . *masking effect mark point can only be awarded overall once for parts (i) and (ii)	
c	parent genotypes + phenotypes . gametes correct from G and H . correct offspring genotypes with lines drawn . offspring phenotypes correct for stated genotypes . genotype / phenotype ratio correct .	No ECF given Parental phenotype given in question Quite a few candidates used their own letters and were penalised one mark for parent genotypes. Some confused between parent phenotypes and genotypes
3a	Enzymes were inactive . Kinetic energy of enzymes + substrates lower . Rate / frequency of effective collisions between enzymes and substrates lower . Formation of enzyme-substrate complexes slower . Rate of enzyme reaction/ breaking down of hydrogen peroxide is slower/ decreases . Max 3m	Majority missed out key words in their responses, resulting in loss of marks. The idea of the effect of increasing temperature on enzyme activity was seen in some responses which was irrelevant
b	Any 2 from enzymes are specific in action . **Active sites** of enzymes in carrots not **complementary** to **hydrogen peroxide** . No enzyme-substrate complexes formed . Essential point Hydrogen peroxide breaks down on its own to release oxygen bubbles . Some candidates interpreted that carrots contained less of the same enzymes / had less permeable cell surface membranes / were not in the optimum pH or temperature	Must make reference to carrot + hydrogen peroxide. A enzyme specificity R generic references to enzyme and substrate R enzymes are specific in purpose / specific in function / specific in nature
c	Cut/crush the potato strips into cubes / smaller pieces . To increase surface area to volume ratio of potato tissue exposed to hydrogen peroxide solution / for hydrogen peroxide to diffuse faster into the potato cells.	R using more / longer strips R changing temperature or pH of solutions R increase surface area to volume ratio of cells / enzymes R diffusion of enzymes

4a	country X has 30% + country Y has 35% blood group A ; country X has 35% + country Y has 9% blood group B ; country X has 9% + country Y has 3% blood group AB ; country X has 26% + country Y has 53% blood group O ; country Y has the least percentage of AB blood group (3%) + but has the highest percentage of O blood group (53%) ; Majority of people in country X has blood group B (35%) + majority of people in country Y has blood group O (53%) ; Any other plausible comparisons Many candidates simply compared data While it is commendable that many stated correct trends and quoted data accurately, little made effort to describe *patterns*.	1st mark Description of Trend 2nd mark quotation of relevant Data to support 3rd mark manipulation of given data to illustrate Pattern R proportion of people with AB blood group is similar in countries X and Y (difference is 3x I) R reading data off the chart without line by line comparison or identification of pattern (no credit will be awarded)
b	Discontinuous . Any one from the following Distinct categories/ groups/ 4 groups. No intermediates. Not controlled by external environment. Controlled by a single gene.	 R controlled by single allele R controlled by one or few genes
c	I^ I^	Alleles must be written separately with a comma in between
5ai	Any one of the anthers on Plant 1 labelled with a label line drawn with a ruler and pencil .	Many candidates missed this question or did not respond according to instructions
ii	self-pollination . Offspring are genetically similar to parents . good traits are conserved in the next generation . Anther positioned next to / near / just above stigma. Higher chance of successful pollination . Not dependent on external factors can happen regardless of wind conditions / presence of pollinators / in the absence of other mates . less pollen grains released .	 R genetically identical R alleles are passed down to offspring (same for cross pollination) R vague reasons e g happen quickly / easily R if energy is implied to be from the pollinator or wind

	conservation of resources and energy (to produce pollen grains) ; ; ny complete set	
iii	Both involves fusion of nuclei of male and female gametes . Both involves the movement of male gametes towards the female gametes . In both cases a large number of male gametes released . Fertilisation is the hall mark of sexual reproduction hence candidates should not provide farfetched ideas into embryo development / sexual organs Candidates are reminded to provide distinct arguments For example both involving male and female gametes + both involving fusion of gametes is one idea Only 1 credit will be awarded	A offspring have genetic variation A involves meiosis during gamete production R both involve cell division (vague) / mitosis for growth (beyond fertilisation) R ovum in ovary (for plants fertilisation occurs within ovary while for humans fertilisation occurs outside ovary)
b	**Insect-pollinated** / **Wind-pollinated** Brightly colored petals / Dull and inconspicuous appearance Nectar / No nectar Nectar guides on petals / No nectar guides Sweet smelling scent / Odorless Fairly abundant number of larger pollen grains with rough/spiky surface / Very abundant number of smaller light-weight pollen grains with smooth surface Anthers and stigmas enclosed within petals/ flower / Feathery stigmas and long filaments with pendulous anthers protruding outside flower	R no petals R pendulous filament R "not" description of other flower A long filament and pendulous anther
6a	disease-causing organisms . eg viruses/ bacteria/ fungi ;	
b	Named body fluid (eg saliva/ water droplets from sneezing or coughing) + method of transmission (eg. airborne/ touching contaminated surfaces) . Choose any two wear mask/ proper hand hygiene routine/ sanitization of commonly touch surfaces using d sinfectant/ rubbing alcohol AVP .	Method of transmission must be well described Candidates need to be clear n their descriptions and simply state the body fluids that contain the pathogens. The process of transmission such as sneezing/ coughing should be stated.
c	Fever/ cough/ chills/ shortness of breath/ bodily pain/ headaches ;	Generally well answered

d	Virus different in structure and reproductive differences than bacteria ; State one structural/ reproductive difference	Most candidates are able to answer this question confidently Some candidates fail to recognise the difference between virus and bacteria
7a	Both axes labelled with correct units . Scales show regular intervals . All plotted points are drawn correctly Line of best fit/ graph drawn + occupies 70% of grid paper ;	This graph should be a graph that is drawn with a smooth line joining all plotted points Some candidates forget to label their axes and this mistake should be avoided at all times.
b	(85.0 – 10.0)/ 10.0 x 100% Final answer = 750 R % sign written as it is provided	I + sign written before 750%
c	radioactive labelled water taken into the root hair cells; osmosis. movement of water/ transpiration stream up the xylem vessels. transpiration pull . photosynthesis occurs in leaves ; water undergo photolysis/ broken down into oxygen . oxygen release into chamber + stomata .	Most answers are able to illustrate the idea of water movement into and up the plant Some students were unable to mention key ideas such as osmosis and transpiration pull and wrongly mention that water moves up the stem by means of diffusion
d	Label on diagram the phloem tissues with letter H . Carbon dioxide is reduced/ converted/ incorporated into glucose/ sucrose . Sucrose translocated .	Generally well answered
8a	Blood containing glucose and amino acids unable to be transported from small intestine/ ileum to liver . No excess glucose to be converted into glycogen for storage . No deamination of amino acids can take place, leading to accumulation of amino acids in blood . Reduction in bile production. Lack of blood supply to liver cells + cell death/ liver failure .	A less glucose, leading to less aerobic respiration and less energy released for bile production Direction of blood flow in hepatic portal vein is TOWARDS LIVER Challenging question. Some failed to recall the function of hepatic portal vein and many struggled to suggest the direct impacts of its occlusion on the patient. Answers that were too vague or which provided excessive

	Lack of nutrient-rich blood transported to rest of body + fatigue. Alcohol that is consumed cannot be transported to liver for detoxification . causing higher likelihood of alcohol poisoning as alcohol accumulates in blood .	elaborations on one impact were not given the full credit
b	Blood unable to clot when an injury occurs. Bleeding profusely. Entry of pathogen causing infection.	
c	Connecting line drawn from the 'Y' junction to the 'T' junction between the demarcated lines  	'Y' junction – to ensure both lobes of liver will receive blood 'T' junction – to ensure blood from all branches of portal vein will reach the liver
d	*Effects on individual* Delayed response/ increased reaction time, leading to increased risk of accidents ; R slower reaction time Reduced self-control, leading to aggressive behaviors . Increased risk of fatty liver leading to liver cirrhosis / gastric ulcers leading to stomach cancer . R idea that these diseases definitely will occur *Impacts on society* Crime rate increase. Family violence/ abusive relationships . Financial difficulties due to addiction . Low employment/ productivity .	Answer must include how alcohol affects the biology of the individual, hence leading to the resultant effects. Candidates must present impacts on both individual AND society to gain full credit

Paper 2 Section B

Mark only 1 question		
9a	lens unable to change thickness and convexness . lens remain thin and less convex when seeing near object . light rays from near object undergoes refraction/ bends when passing through cornea . light rays when pass through (thin and less convex) lens, unable to bend and be focused on the retina . Light rays focused in front or behind the retina . Max 4.	R less light rays focused on retina. light rays reflect Poorly done Unnecessary description on nervous pathway Many recited the accommodation reflex but did not explain the effects of inelastic lens from the context Inaccuracies in structures and shape of ens were observed too
b	Photoreceptors in the eye detected the stimulus (approaching baseball) . Nerve impulse is generated in the receptor + impulse transmitted by sensory neurons towards the brain. Nervous impulse transmitted to the relay neuron . Across a synapse . to the motor neuron . nervous impulse transmitted along motor neuron towards effector eye lid muscles . eye lids/ effector muscles contract and relax to produce blinking movements . Max 6.	R reference to CNS

10a	Combustion/ burning of fossil fuels, Burning of non-biodegradable wastes such as plastic wastes. Releases carbon dioxide into the atmosphere. Intensive cattle farming releases large amount of carbon dioxide and methane. Deforestation/ indiscriminate cutting down of trees; Less carbon dioxide gas absorbed by photosynthesis, Carbon dioxide is a greenhouse gas + traps Sun's heat in the atmosphere, causing global warming.	
b	*Answers should be in pairs. 1m to describe the action (A) + 1m elaborate (E) on how forest biodiversity or forest habitat can be conserved* Public education programmes to raise awareness of the importance of conservation. Encourage people to participate in conservation & reforestation efforts; Encourage people to practice good habits e.g., avoid buying products made from endangered animal and plant parts; Reforestation and rehabilitation of restored forests by planting native tree species and reintroduce native animal species, Allow forest to re-grow and forest patches to be connected; Allow species diversity and richness to be restored, Protect natural habitats by setting these habitats as nature reserves or national parks. Legislation to limit logging activities in these protected areas, Allow flora and fauna to thrive and grow in these protected environments, Legislation to limit and regulate cutting down of trees; Prevent ind scriminate deforestation, Legislation to rotate permitted logging areas, Allow trees to regenerate, Legislation to protect endangered species from being hunted/ poached, Allow time for endangered species to reproduce and recover in numbers;	*Note accept maximum 2 methods at individual leve*

<table>
<tr><th>Qn</th><th>Answer</th><th>Marker's comments</th></tr>
<tr><td>1ai</td><td>The agar closest to the well / hole is pink / yellow ;</td><td>Most well done.</td></tr>
<tr><td>ii</td><td>From the edge of the well / hole to the edge of the pink / yellow circle / zone ;
Diameter / radius of the pink circle ;</td><td>Candidates need to provide clear description on how to measure the distance travelled. They need to use words like red colour zone instead of vague descriptions like the distance travelled by citric acid which cannot be seen if not for the colour.</td></tr>
<tr><td>iii</td><td>• Table drawn with header line + two columns ;
• Headings: concentration of citric acid + distance / diameter ;
• Units in header only; percentage / % + mm / cm ;
• Three distances recorded in correct column + increasing trend ;
<table><tr><td>Concentration of citric acid / percentage or %</td><td>Distance moved / diameter of circle / zone / mm or cm</td></tr><tr><td>0.5</td><td>4 / 3.4</td></tr><tr><td>1.0</td><td>...5</td></tr><tr><td>5.0</td><td></td></tr></table></td><td>Generally well done with trends being observed.

Careless mistakes such as writing units in the cell of the table should not happen anymore.

Measurements done in mm scale must be in whole numbers.</td></tr>
<tr><td>iv</td><td>The higher the concentration of citric acid, the further the acid moves / AW</td><td>ECF – conclude base on aiii

Weaker answers include the mentioning of higher rate of diffusion of citric acid. This cannot be observed from the table of results and must be calculated.</td></tr>
<tr><td>v</td><td>Diffusion coefficient = (14x14) ÷ 30
= 6.5 ..</td><td>Some careless mistakes were seen with candidates not following the instructions stated in the question.</td></tr>
<tr><td>bi</td><td>2 ..
• Number of drops / three drops of acid in the holes
• Concentration / depth / volume / type of agar
• Depth / size / width of holes / wells
• Concentration / volume / type of indicator
• Duration of experiment
• Same type of acid</td><td>Generally well done with some points being repeated twice and therefore received only 1 out of 2 marks.

The term 'amount' should be avoided. Terms like volume will be a better replacement.</td></tr>
<tr><td>ii</td><td><table><tr><td>error</td><td>effect of results</td></tr><tr><td>drop sizes vary ;</td><td>larger volume produces greater diffusion distance ;</td></tr><tr><td>no repeats ;</td><td>unable to identify anomalous results ;</td></tr><tr><td>citric acid added at different times circles measured at different times ;</td><td>greater distance travelled by acid in the well in which acid was added first / measured last ;</td></tr><tr><td>difficult to judge edge of colour change / subjective ;</td><td>results overestimated or underestimated ;</td></tr></table>R: air bubble in syringe, maintaining a constant temperature, "cannot" determine edge of colour change</td><td>Mark as a pair, effect must match the source of error.

R: evaporation of water from well (relatively small exposed surface area)
A: correct explanation about how evaporation increases concentration of citric acid leading to faster rate of diffusion</td></tr>
<tr><td>c</td><td>Max two for dependent variable ;;
▫ holes made in agar stained with appropriate pH indicator
▫ measure distance moved/diameter/radius of zone/ measure time taken to reach specified diameter

Max two for independent variable ;;
▫ using range of at least 3 specified temperatures and all less than 70°C
▫ specified logical method of keeping temperature constant e.g. water bath, incubator

Max two for variables to be kept constant ;;
▫ left for fixed specified duration / fixed specified diameter
▫ specified same concentration of citric acid ;</td><td>

R: 0 °C

R: boiling water bath, air-conditioned room, lamp, fridge, water bath in beaker for agar plates
A: heating lamp with specified distance from agar plate
Some candidates mentioned setting up of water bath but did not mention placing tubes / plates in the bath hence credit cannot be awarded;</td></tr>
</table>

	any additional points ; repeating the investigation at least twice ; wear gloves / goggles . ref to temperature equilibrium time prior to adding citric acid . Plot graph of distance moved by citric acid / mm against temperature of agar / °C ; The larger the distance moved by the acid implies a faster rate of diffusion ; AVP :	R: "optimum" temperature for diffusion, or conclusively stating how higher temperature results in faster rate of diffusion
2ai	Temperature of water in the beaker ;	R: temperature of surrounding & aquatic plant A common mistake is to identify light intensity as the independent variable when the context given is "at six different temperatures".
ii	To identify anomalous results / to ensure/ increase reliability of results ;	Accuracy and reliability are not the same.
bi	A: Axes labelled with units ; S: Scale ; P: Six correct plots ; L: Best fit line .	It is a known relationship between temperature and rate of photosynthesis hence it is a smooth curve. 1m is deducted under "P" for those who added a plot for part (iii) on their graph. Quite a few candidates used an odd scale of 10:0.25cm^3 per minute and are penalised under "S".
ii	As temperature increases from 5°C to 20°C, rate of photosynthesis increases from 0.25cm^3 per minute to 1.14cm^3 per minute , As temperature increases from 20°C to 30°C, rate of photosynthesis decreases from 1.14cm^3 per minute to 0.08cm^3 per minute ;	It is necessary to quote data in the answer to describe the pattern or trend shown by the data in the graph.
iii	Correct reading of value from candidate's graph + 2 d.p. .	It is important to choose an appropriate scale to enable accurate reading of the value from the graph. Candidates are penalised for not recording the value to the correct number of d.p. presented by the data and the scale.
ci	*Line: Outline clear single lines without shading* . Size: occupies at least half of the space available ; Detail: one stigma and five anthers right aligned, seven petals with nectar guides Proportion (size, length, position); Stigma labelled ;	R: drawing over-exposed parts. These are not structures of the flower. During O's, if the space allows, make your drawing to be bigger than the picture. Magnification must be larger than or equal to 1.
ii	Length of line **XY:** 99 / 100 / 101 mm , 17 mm ;; MP1 correct measurement of line **XY** MP2 correct calculation MP3 whole number and correct unit Ecf MP2 and MP3 from incorrect measurement	
iii	Cross pollination / insect pollinated ;	R: animal pollination Question's context is bees and wasps, so be specific. Also, it is wise to choose answers that are more available in the syllabus.
iv	Increase in / more genetic variations in offspring ; Increases chance of survival of offspring ; More adapted to changes in the environment , Foraging for nectar is species-specific in insects, hence reduce loss of pollen grains / increasing chances of stigma-pollen compatibility	R: prevent self-pollination (vague) A: species/population less susceptible to diseases MC: Confusion between alleles, genotype and phenotype. Cross pollination results in higher probability of offspring being heterozygous hence, less likely for harmful recessive alleles to be **expressed** (i.e., less likely to have the harmful recessive phenotype). Probability of inheriting each allele from each parent is NOT affected.
v	Fertilisation / germination of pollen grain/tube;	